FICUS ELASTICA:

ITS NATURAL GROWTH AND ARTIFICIAL PROPAGATION.

WITH A DESCRIPTION OF THE
METHOD OF TAPPING THE TREE AND OF THE PREPARATION
OF ITS RUBBER FOR THE MARKET.

BY

E. M. COVENTRY,

Deputy Conservator of Forests.

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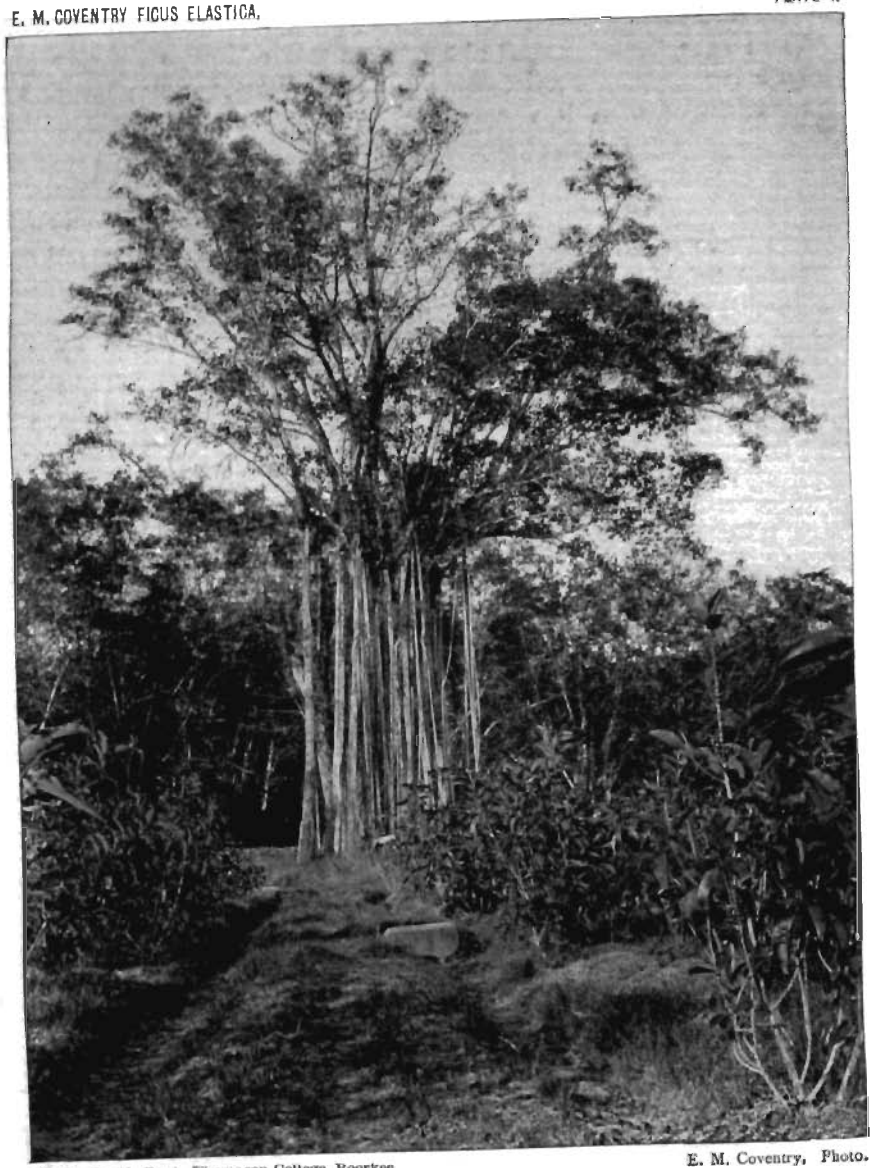
ON THE TAPPING OF FICUS ELASTICA AND THE PREPARATION OF THE RUBBER FOR EXPORT.

INTRODUCTION

THESE notes are compiled from the literature available on the subject and from personal observation. The writer obtained much information from reports prepared by Mr. D. P. Copeland and other Forest officers, who from time to time have been connected with the Charduar and Khulsi Plantations, and from Mr. M. H. Thompson, Deputy Conservator of Forests' Report on the Hukong Valley in Upper Burma.



Photo,-Mechl. Dept., Thomason College, Roorkee. E. M. Coventry, Photo.

NATURAL RUBBER TREE ABOUT 120 FEET HIGH.

This tree yielded 80 lbs. of rubber at one tapping.

NOTES ON FICUS EL/

CHAPTER I.

ON NATURAL GROWTH AND ARTIFICIAL PROPAGATION.

(I) THE NATURAL GROWTH.

Distribution.

THE FICUS ELASTICA occurs in suitable localities in the foot hills of the Himalayas from Nepal eastward; it has been found in the Khasia Hills up to an elevation of about 3,000 feet and is reported from the Hukong and other valleys of Upper Burma up to nearly 5,000 feet above sea level. In Assam the trees are found in the greatest number in the Darrang and Lakhimpur districts, but large quantities of rubber are imported into the Province from Bhutan, the Aka Duffla and Naga Hills and from Burma.

It is found as a dominant tree in the evergreen forests of Assam; the finest specimens in hilly country up to an elevation of 2,500 feet. It is not a gregarious tree, but in the Hukong Valley is reported as appearing scattered generally through the dense evergreen forests, occasionally a family group of four or five trees may be met with, but these are very rare indeed and the usual thing is to come across a mature tree at a distance of every 200 to 300 yards in the richer forests.

Climate required.

2. Mr. Thompson writes that the main factor determining the distribution of this species seems to be excessive humidity of the atmosphere. It appears to be able to accommodate itself to many varieties of soil (probably because in nature its earlier stages are passed on a host) and to be indifferent generally speaking to large variations in altitude, though growing best in Burma at 2,500 to 3,500 feet. The absence of a very high temperature would also seem to favour its growth, as the species is unknown in otherwise suitable localities in Lower Burma. However, this latter point may or may not be correct and very likely the question may be complicated

by correlation of factors that we are not as yet cognizant of. But this much is certain that it is found growing in abundance on the Lounau hills at an altitude of 5,200 feet and is reported from high altitudes in the Jan Mun Bun mountains to the east of N'tupusa on the north and south watersheds of the Taron river, the higher crests and peaks of which are covered with large masses of snow in the winter. It does not appear to actually grow in places which are subject to snow-falls, but is found in all the damp, deep gorges on the slopes of such hills, very often creeping up the latter to considerable altitudes.

If the tree does not actually grow high up in the mountains, it yet must experience severe winter frosts, but it is probable that the influence of the latter is modified to a certain extent by the position of the seedlings on the stems of their hosts, and they very likely do not suffer to the same degree as they would if growing on the surface of the soil.

The trees planted at Shillong, elevation 4,000 feet, died during the severe winter of 1904-05, but as on this occasion indigenous trees over many hundreds of square miles were killed by frost this evidence is far from conclusive.

Description of the tree.

3. A gigantic, evergreen tree (often 100 to 120 feet in height) sending down numerous aerial roots from the branches, it is easily recognised by its large glossy leaves and, during the growing season, by the large red stipules which surround the leaves and which drop off as the leaves unfold. At Charduar the natives distinguish two varieties—Bogi Bor and Shika Bor. The former is affirmed by them to be the better and has much larger leaves than the other.

Natural method of growth.

4. The tree is essentially a light-demanding species and, though an evergreen and associated with and growing amongst dense shade-bearers, no tree can be more exacting in its demands for light. Wherever it is surrounded with dense shade it will be found that this tree, in order to escape from it, has grown to enormous heights, in many cases towering head and shoulders above every other tree in its vicinity.

Seedlings grow as a rule in the fork or crevices in the bark of the light-foliaged trees (Dalbergia, etc.) at a great height from the ground and occasionally on the half-rotten trunks of dead and dying trees in places where from windfalls or otherwise clearings have been formed in

the leaf canopy. The young seedling thus obtains a good start over its rivals in the struggle for existence.

The young plant remains an epiphyte for years until its aerial roots touch the ground: as soon as this takes place, the little epiphyte changes rapidly into a vigorous tree, throwing out numerous aerial roots which gradually envelope the tree on which it first began life and often kill it. Having started life so high up, it is able to throw out branches which overtop the surrounding trees, and the numerous aerial roots which fall from these and establish connection with the ground enable it in a few years to dominate the forest growth around it.

In accordance with its light-demanding character seedlings growing on the ground are extremely rare. That they will grow on the ground is, however, proved by the seedlings found in tea gardens where the ground is kept clear. Also trees which have originated from seed that has germinated on the ground are said to be not at all rare in the Aka Hills.

Underground roots.

5. In 1892-93 and the two previous years attempts were made to kill out the suppressed rubber trees in the Charduar plantation by tapping them heavily. However, on examining the roots it was found that those of neighbouring trees had anastomosed, so that the plantation had practically become one huge tree. The roots spread out near the surface of the ground to a distance of 150 feet or more. Those of "gooties" or Chinese grafts and cuttings are rather brittle and snap off, if planting is not carefully done.

Aerial roots.

6. The vigour of a tree may be gauged by the number of its aerial roots, even seedlings soon establish their connection with the ground by numerous aerial roots. The aerial roots will anastomose with one another or with any part of the trunk or branches with which they may come in contact and such a root of one tree may even join on to the branch of another. In 1897-98 one of the large aerial roots of a rubber tree in the Charduar nursery, which in its descent had anastomosed with another aerial root of the parent tree, was severed at its upper end, since it did not die this proved that it had completely anastomosed. Numerous roots are also put out from the edge of the cuts made in the tapping operations and these often establish connection with the ground within a year. Also, if aerial roots are inserted in split

bamboos filled with earth, they quickly reach the ground and rapidly increase in size.

Seed and fruit.

7. The seed is contained in a fig-shaped fruit, the size of a pea, about 75 seeds, the size of a pinhead, being found in one good, sound fig. The fruit first begins to form on the trees in March and ripens from May onwards to December. On some trees the whole crop ripens and falls off by June, but, as a rule, the tree has fruit on it from April to December, the figs forming, ripening and falling off during the whole of the rainy season.

Description of seedling on germination.

8. The embryo appears on the germination of the seed as a seedling having a pair of opposite cotyledons with an entire margin, destitute of incisions or appendage of any kind, with the exception of the notched or emarginate apex, oval in general outline, green in colour and of a glassy smoothness. The second pair of leaves shows a tendency to the alternate arrangement on the stem, but appear at the same time. Their shape and variation are very different to those of the primary leaves, for they have a central midrib and a distinctly coarsely crenated margin. The third pair of leaves do not appear simultaneously and are distinctly alternate, with a marked reddish colour: after this period is passed the plant is easily recognised.

(ii) ARTIFICIAL PROPAGATION.

(a) Various methods described.

Requirements of young rubber plants.

9. The general conditions for the healthy and rapid growth of the young trees of Ficus elastica are:—

(1) Perfect drainage about its roots and looseness of soil so as to admit the air readily, the composition of the soil not so far as is known seriously affecting the trees as long as the above conditions are fulfilled: but gravel or sand does not appear to be suitable since all the caoutchouc collectors state that the trees produce much smaller quantities of rubber when grown in such soil even in the best localities.

(2) Plenty of light.
(3) Heat and moisture combined, or what is commonly termed a close, steamy atmosphere.

There seems in short to be no doubt as to what is required to make this ficus thrive and this may be summed up in the few words, air, light, good drainage about the roots and as much moisture in the air as possible.

The last condition, of course, is very present at the foot of mountains which is the situation of Charduar, and this is encouraged by only clearing lines through the forest at a hundred feet apart and leaving the natural vegetation standing between these lines. Another very necessary requirement to ensure plenty of air and light is the constant clearing of the dense scrub round the young trees which grows with marvellous rapidity. The drainage about their roots is ensured by planting on mounds.

It has been asserted that the rubber tree grows equally well on high land or low land, in forest land or grass land, so long as it is planted on a mound and its roots are not exposed to the sun; and that it is a surface feeder, but, as soon as its roots appear above ground, they must be covered with fresh earth until such time as the tree has formed a sufficient leaf canopy to protect itself. But the statement that the tree grows equally well everywhere cannot be accepted as correct. In the first place it does not grow well in swampy ground, or in places where water stands for a large part of the year, *e.g.*, the trees planted on mounds along the Dhekrigaon road which is bordered by rice fields have hardly grown at all, though planted in 1879-80, and many of them have died. Where the trees are in low places, with water on the ground the greater part of the year, it does not suit them even though they have been planted on mounds. They then become sickly and will probably die in a few years. Floods have occasionally killed all the seedlings in the nurseries.

In the second place rubber does not appear to grow well in grass lands where there are no trees. Most of compartment 18 consists of land of this description and the plants here are very sickly and have hardly grown at all and probably will not come to anything. Many have died. This may be due to absence of shade; but the composition of the soil of such lands is probably unsuitable to the growth of trees.

10. Experiments made in 1897-98 showed that rubber can be easily grown in this way.

Propagation by layers.

11. The tree can readily also be propagated from cuttings if only perfectly ripe young branches or shoots are used, but the trees raised from cuttings do not appear to throw out aerial roots, and, as the future yield of the tree probably depends on the number of these roots, it is questionable whether trees raised from cuttings should be used except where required for shade as in an avenue. In the Charduar plantation propagation by cuttings was given up very early, that is after 1876, the plantation having been commenced in 1873.

Cuttings.

The best time for making cuttings in Assam is, no doubt, from the middle of January to the end of May, it depends on the rainfall during the latter three months which of the cuttings will do best: those made in 1874 after May failed almost entirely. The earlier in the season before the trees from which the cuttings are obtained have started growth the better chance the cuttings have of success. At this time young terminal shoots will grow well whilst, after the trees from which the cuttings are taken have commenced growth, which happens about the end of January, the lower, somewhat harder portion of the young branches succeeds better than the soft terminal shoots. Only young and vigorous branches from lopped trees are used, and they are cut from one to two feet in length and are put three inches in the ground. All scrubby branches from old trees almost invariably fail. The branches of young trees succeed better than those of lopped trees.

In 1875 the preparation of cuttings was begun at the end of January and continued till the middle of March. They were planted on raised beds. Artificial shading of grass was employed, the shades being removed every afternoon and not replaced until about 9 A.M. In the middle of March rain fell and continued for some time when opportunity was taken advantage to harden off the cuttings and to remove the artificial shading. Until rain fell all were watered twice a day. Whilst cuttings form at once larger plants and grow faster during the first year or two, seedlings are hardier and stand transplanting better than cuttings. It appears to be inadvisable to transplant cuttings till they are two years old. Cuttings from vigorous top-shoots cut and put in the ground before they have started new growth in December and January make roots readily.

In 1895 large cuttings, twelve feet in length, were used. All the green parts were cut off and they were fixed two to three feet in the ground. They were planted on mounds and tied to stakes. A few were planted in March after heavy rain, as an experiment, and the remainder in May and June. Of 21 cuttings planted in March to fill up vacancies one has died, or 5 per cent.: of 82 planted after the rains had well set in, 23 died, or 28 per cent. Several cuttings were planted in May, before the rains began, and whilst it was very hot, but these nearly all died. From the above it would appear best to plant cuttings before the growing season commences, that is before the end of March.

Gooties.

12. Gooties or Chinese grafts have been used since 1902-03 for filling up blanks in the plantation. To prepare gooties, vigorous young branches 12 to 20 feet long are selected, those still covered with red bark probably giving the best results. A strip of bark 3 to 8 inches wide is then removed, care being taken not to injure the wood, at the point where the roots are wanted, and this should be at least 9 inches above where it is proposed to saw off the branch in order to allow the gootie to be firmly fixed in the mound. At the point in the branch where the bark has been removed a large lump of wet clay, mixed with cowdung, is tied on with a piece of gunny cloth and kept wet till such time as small root-lets appear through the cloth when the gootie is ready for planting out. During the rains the roots appear in about three weeks to a month's time, and in Assam the best time for preparing this form of graft is April and May; they should be planted out during May and June.

The gooties should be planted at least 2½ feet to 3 feet deep in the mound and should be tied to stakes as in the case of seedlings. It is not yet known whether gooties are likely to give successful results. Out of 83 gooties carefully planted in compartment 12.C. in the rains of 1904, 21 died, or 25 per cent., while those gooties planted in other compartments have mostly failed. They usually dry off at the top and consequently pruning of the ends of their branches might have good effects.

Seedlings planted in the forks and on the branches of trees.

13. In imitation of the natural method of growth seedlings have been planted on the branches of trees but the growth is very slow until the roots reach the ground after a number of years; and this method of cultivation has now been abandoned. Experiments

were started in 1875 to plant the young trees in strongly made cane baskets and to place these in the forks of trees. Only seedlings were used for this mode of planting, because they form thick tuberous roots and thus are more fit to cope with the comparative dryness to which they are exposed in the tops of trees in the dry season. The first of these was planted on January 25th in trees near the nurseries and up till the 21st April they looked everything that could be desired; in all 400 plants were put out, but in May 1905 only one survived. It appears that in the three years following the planting the seedlings either remained stationary or made one or two leaves only, which is attributed to the want of moisture in the soil provided in the baskets and also to shade from above which is necessary in order to retain some moisture in the soil. Thus on the one hand to prevent excessive evaporation shade is required and on the other the presence of shade is prohibitive to the growth of the seedlings. The cost of stocking the plantation by this method amounted to about Rs. 5 per acre, but, as before noted, the system has been abandoned as unsuitable.

Planting on split stumps, etc.

14. Before the system of planting on mounds was established, seedlings were planted experimentally on split or hollow stumps of trees. The planting on split stumps of trees and in earthenware tubes placed on stumps proved very successful in low situations, counteracting the effects of excessive moisture; but vigorous growth was not attained without the admission of light. The trees planted on low split stumps, or in earthenware cylinders placed on stumps or on piles of wood put crossways and mixed with earth, or on small mounds of earth about 2—3 feet in height all succeeded well in the lines cleared through the forest, and this being so all plants are now planted on mounds of earth, raised about 3 feet above the ground, this being found to be the most economical way of working. In Upper Burma experiments have been made to propagate the species by placing cuttings or seedlings in hollow teak stumps, which are previously filled with earth, in moist or evergreen forests, and they are found to grow vigorously and are out of the reach of animals. It has been found that better results are obtained from the planting of young, well-rooted seedlings than of cuttings. Seedlings are, however, difficult to obtain and are expensive, the Kachins who supply them being paid about twelve annas to one rupee a plant. Several hundred

seedlings have been planted out and in 1904 were reported to be growing vigorously.

(b) Reproduction by nursery seedlings.

Collection of seed.

15. Seed should be collected from trees over 20 years old, but not over-mature, as experience has shown that seed collected from younger trees will not germinate. It is advisable to gather seed from beneath the trees when the figs are ripe and birds have begun to feed on them. The bird droppings and ripe figs found on the ground should be swept up daily, since the seed that has passed through the alimentary canals of birds germinates best. The seeds thus collected may, however, contain other varieties of fig which ripen at the same time, but very soon after germination different varieties are easily recognised and can be weeded out. The sooner after collection the seed is sown the better, but if seed has to be kept, the figs should be carefully dried and mixed with pounded charcoal, which preserves it for many months.

Preparation of the nursery.

16. A site should be chosen for a nursery where the soil is good and there is some shelter, and a well or stream should be near so that the plants can be watered. The land selected should be ploughed up and allowed to lie fallow for some time to prevent the growth of moss, etc. It should then be watered and levelled, all stumps and roots being removed, and finally drained and fenced. The seed beds should then be prepared while the rest of the nursery is marked off into beds to receive the transplants. All the beds should be raised one foot, having small paths between them, and for the seed beds good soil containing vegetable matter should be brought in.

Preparation of the seed-beds.

17. To prevent the soil of the seed-beds being washed away, small pegs are driven into the ground along the outer edge of each bed against which some reeds are tied horizontally and thatching grass is then put on the inside of the reeds. The soil should be pulverised and passed through seives and levelled, then 3 inches of charcoal dust should be spread over the beds and mixed up with the soil by hand. The beds are then smoothed down and are ready for sowing. Light sandy soil is the most suitable for seed beds: if the soil is stiff, charcoal-dust or river-sand should be

mixed with it to make it porous and prevent caking. The seed beds must never be allowed to get dry.

Shades for the seed-beds.

18. Light, movable shades are put up over the seed-beds to intercept the direct rays of the sun and to prevent the seed being washed away by rain; they are removed at night and during cloudy weather. They may be made of thatching grass or bamboo mats. When planting operations were started, it was found during the first few years that seedlings died in large numbers, and in 1877-78 a side-shade, 7 feet high, was put up vertically along the Southern edge of the beds, and it was noticed that wherever the sun got at the seedlings over the top of the shade, they were all killed. It is believed therefore that shade is absolutely necessary for the young seedlings for some time after germination. It was also found by experience that seedlings and cuttings were very susceptible to injury from too much shade or drip from the trees left in the nursery causing excessive moisture about their roots, and that artificial shade over the seed-beds caused drip and excessive moisture which proved fatal to many seedlings. Consequently, the seed-beds must not be allowed to become too damp, but on the other hand the seedlings must be protected from the sun.

Method of sowing.

19. At present seed is sown as follows:—For a seed-bed, $40' \times 3\frac{1}{2}'$, two to three seers of broken figs, 10 seers of ash and 20 seers of vegetable loam or good soil are well mixed, about a pint of kerosine oil being added to prevent ants and other insects carrying off the seed. This mixture is spread evenly over the bed and then lightly tamped down and watered. Such a bed should yield with good germination 2,000 seedlings and should be sufficient for planting up 100 acres of rubber. The figs are broken between the hands and as the seed is very minute, the particles of the fruit are left with the seed and sown with it, no attempt being made to clean the seed by separating the pulverised fragments of the figs.

In 1874-75, 30 seers of fruit were sown in three different ways:—

1st.—On beds covered with broken bricks, half of which was sown with entire figs and the other half with the fruit broken up or rubbed into powder between the hands.

2nd.—Sown like the above, but on broken charcoal.

3rd.—Sown like the above, but on earth only.

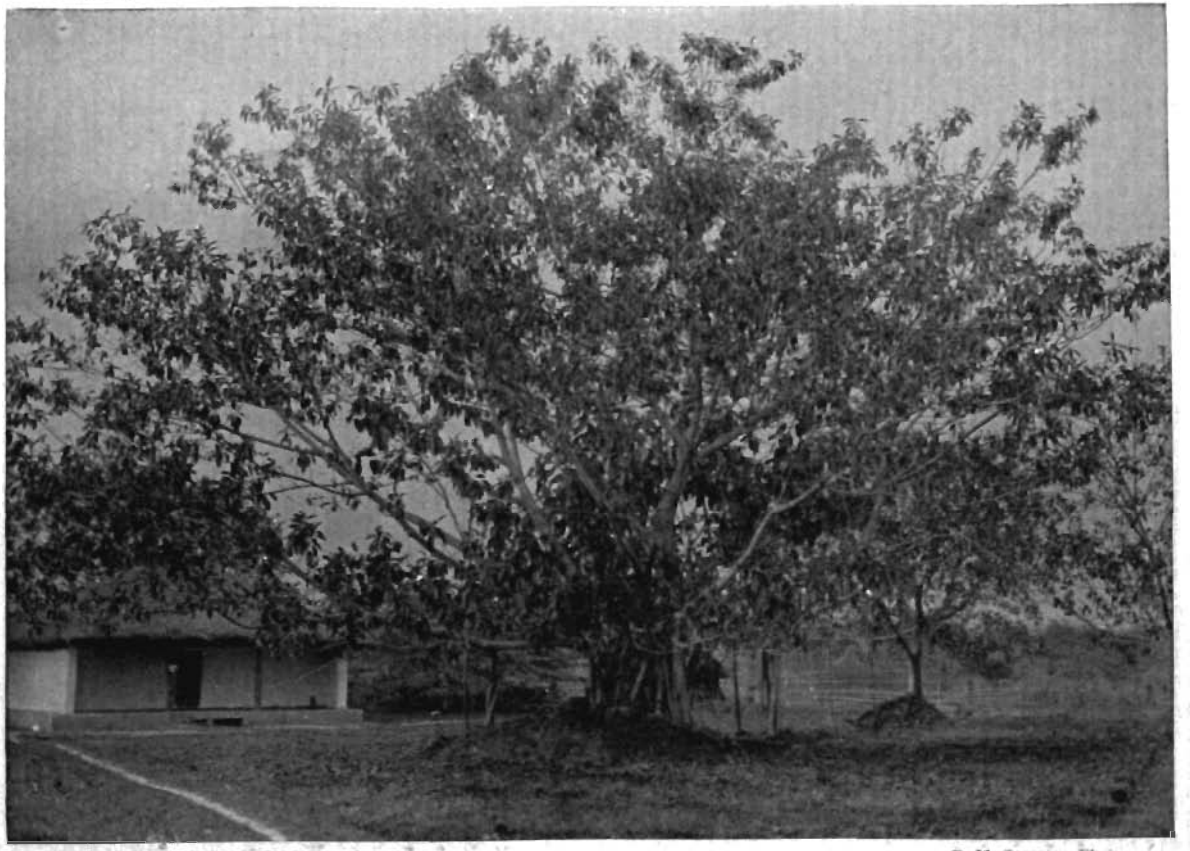


Photo.-Mechl. Dept., Thomason College, Roorkee. E. M. Coventry, Photo.

PLANTATION TREE, 55 FEET HIGH, ABOUT 15 YEARS OLD.

The seed was sown in the middle of January and germinated in the middle of April. Germination took place best on the broken bricks, next best on the charcoal and least on the earth. When the rains set in heavily, the seedlings on the charcoal stood it best, those on the broken bricks next, whilst those on the soil nearly all perished. These beds were not shaded. There was no difference in the germination of the seed when the whole fruit had been sown and the fruit had been crushed, except that in the former case the seedlings were very much crowded.

A similar experiment is described in Gamble's "Manual of Indian Timbers." In this case the germination was best on garden soil, next best on the broken bricks, and last, though still very good on the charcoal. Here, however, the beds were irrigated and shaded.

In 1877-78 another experiment was made. Seed was sown on 33 beds. Of the above beds, one was prepared with earth only, without charcoal, and produced 3,011 seedlings, 20 beds were prepared with rather coarsely-broken charcoal, and the latter but slightly mixed with the soil. These produced an average of 707 seedlings to each bed: 12 beds were prepared with very finely-broken charcoal well worked into the soil and produced an average of 1,864 seedlings on each bed. The beds were shaded.

In 1879-80 30 beds were prepared: 5 consisting of plain earth well dug and cleared of roots and weeds: 18 others where the soil was mixed with charcoal as heretofore: and in the remaining beds manure was used.

Whilst on the beds of plain earth the weeds and moss came up very profusely, those in which charcoal was used were comparatively free from either weeds or moss, and on those beds where manure has been used, the number of plants that came up was very much less than on the other beds, but the seedlings looked more vigorous.

In 1896-97 lime was mixed with the soil of one of the beds. In this bed after germination the seedlings pushed far ahead and were fit for pricking out long before the others. This experiment does not appear to have been repeated.

20. Germination takes place from the end of April to the end of the rains. Seed sown between October and January requires daily watering and screening from the sun and will not germinate before the end of April

Season for sowing.

or the beginning of May, but seed sown at any time during the rains will germinate in a few days, from five days to a fortnight. It follows that the best time for sowing seed is during the rains, that is, from June to September. Seed might be sown in May, but the weather is generally too hot then. Previous to 1897 seed was sown in the cold weather months, but from that year it has been sown during the rains. In that year seed was sown weekly during the rains. After September 27th very few seeds germinated, and after October 4th germination ceased. It has, however, been found at Charduar that a good deal of the seed germinates in the following, or even the second, year after sowing.

Weeding and watering.

21. The seed-beds must be kept clear of weeds and watered when necessary, as they must never be allowed to become quite dry.

Transplanting.

22. When the seedlings are one to two inches high in the seed-beds they should be transplanted into nursery-beds and put out in lines about a foot from each other. The nursery-beds should be well raised and drained, but the soil need not be so carefully prepared as for the seed-beds. Here the plants are kept till the following rains, when they are dug up and taken to stockaded nurseries in the forest, and put out 5′ × 5′ on raised mounds where they remain until they are large enough to plant out.

About ten days or a fortnight before the transplanting takes place the shades should be removed from the seed-beds, so that the seedlings may be hardened off. If this is not done, the seedlings are liable to be killed by the sudden exposure.

Season for transplanting.

23. When the plantation was started and during the first ten years, transplanting appears to have been done in the cold weather. The report of 1875-76 states that the best time for transplanting appears to be November and December, before the winter rains. In the following year it was thought that October was the best month. But experiments made in 1878-79 showed that transplanting can be done at any time of the year, provided that ordinary care is exercised and the roots of the plants are not damaged. During dry weather watering would be necessary. In this year twelve plants were put out each month and they all did equally well. At present transplanting is done during the rains, and this is

necessary when large plants, 10—12 feet high, are used, since damage to their roots is unavoidable. The best time in Assam is perhaps between May and July.

Forest nurseries.

24. To avoid the carriage of seedlings for long distances, it is advisable to establish forest nurseries near the areas which are to be planted up. Almost every animal will eat the young rubber plants ; it is, therefore, impossible to plant out small seedlings in the forest, owing to the destruction by wild animals and deer, which will break down plants up to 10—12 feet high, unless each individual plant is fenced in or tied to stakes. This was done when the plantation was started. Fences of plaited bamboo costing 2 to 4 annas each as well as other kinds were used. But these proved insufficient to protect the plants, and in 1878-79 a strong fence was made right round the plantation with the object of keeping out deer. This was very costly, owing to the constant repairs that were necessary, and since the tree after it is 1—2 feet in height is very hardy, the seedlings are kept in stockaded nurseries in the forest where planting operations are to take place and remain there until they are 10—12 feet high. They are then planted out in the forest. The nurseries must be kept free from long grass and under-growth which should be cut from time to time and heaped round the roots of the young plants in order to keep the soil moist and to serve as manure. Seedlings should not be transplanted into the stockaded forest nurseries until they are at least 1 foot high. Smaller plants generally die, unless they are watered, and this is not done in the forest nurseries.

(c) Planting in the forest.

Clearance of the lines.

25. Before planting out seedlings, lines are cleared through the forest, all trees and shrubs being cut level with the ground over a width of 20 feet. Any very large trees standing between the lines are felled at the same time, for if felled later on, they are liable to fall on and break the rubber plants. A path should also be made along the lines to facilitate inspection of the plants.

When the Charduar plantation was commenced lines 20 feet broad were cleared through the forest at distances of 100 feet apart and the

plants were put out in the lines 50 feet apart. Interplanting was done in 1878-80 so that the plants were 25 feet apart. In 1892-93 the planting distance was changed to 70′ × 35′ and again in 1901-02 to 66′ × 66′ which gives ten plants to the acre. But it would seem preferable to plant the seedlings closer together in the lines, for when planted 66 feet apart, it requires some years before they grow together. It would perhaps be best to plant them 33 feet apart and to thin out when necessary. Cuttings might be planted alternately with the seedlings.

At first the lines were cleared due east and west, but of late they have been cleared due north and south. By the latter method the plants are shaded from the afternoon sun.

Mounds.

26. It has been found best to plant rubber seedlings on mounds, because the roots spread out near the surface of the ground. Seedlings planted in the ordinary way did not grow well. Stakes about 20 feet long and of a minimum diameter of 3 inches are set up in the lines at a distance of 66 feet apart and round each a mound 4 feet high is thrown up. The base of the mound is about 10 feet in diameter and it tapers to 4 feet diameter at the top.

Planting out.

27. Only seedlings over 10 feet in height are planted out in the forest at present. The roots are very large, so that they have to be cut off, leaving only 18 inches all round the plant. Some branches are also pruned off if necessary. In 1881-82 it was found necessary to prune off the lower branches and leaves from the trees, otherwise the deer were found to be induced by the taste of them to make desperate efforts to break the trees with their feet and horns to get at the top or crowns of them. The plants are carried to the forest and planted on mounds, care being taken to spread out the roots before they are covered with earth. To prevent animals pulling down the plants and the wind blowing them down, they are tied to stakes in at least two places, one being high up at 8 or 9 feet from the ground. The mounds should then be covered with grass and branches which when rotten act as manure. Rotten thatching grass is the best, as it does not ferment. It is impossible to put too much on and the more the better, but there should be at least 6 inches all over and 1 foot on the top. This operation should be repeated whenever the lines are cleared. It is money well spent as it doubles or trebles the rate of growth.

(d) Maintenance of the plantation.

Clearance of the lines.

28. Rubber plants require plenty of light. It is, consequently, absolutely necessary to keep them free from climbers and from being suppressed by the undergrowth which springs up with marvellous rapidity. If the lines are not cleared, the plants are soon smothered with climbers and killed. Formerly (in 1878-80) the lines were cleared three times a year, *viz.*, in May-June, August-September and November-December, but at present, owing to the scarcity of labour and the large quantity of work which has to be performed, this is only done once a year, after the rains. The climbers and the undergrowth should be cut so as to free the plants all round. There should be nothing in contact with the plants on any side. If any trees are standing above, or shading the plants too much, these trees should be felled, or at any rate some of their branches should be lopped off. But so long as the plants are freed all round, it appears an unnecessary expense to clear the lines to their full width between the plants at any rate every year. It should be sufficient to clear a path for purposes of inspection from one plant to the next.

Replanting vacancies.

29. All plants which have died should be replaced during the following rains. When the lines are being cleared, if any vacancies are found, the mounds and stakes should be prepared at once so as to be ready for planting when the rains set in. A note should be made of the numbers of the lines and of the number of vacancies requiring replanting in each. This will save much time, as it will be unnecessary to go over all the lines again and count the number of vacancies, as has generally been done.

Stakes.

30. Any stakes found to be rotten should be replaced when the lines are cleared if the plants are still small and liable to be broken down by deer or thrown down by the wind.

Mounds.

31. All grass and undergrowth cut when the lines are cleared should be piled on the mounds.

Felling trees between the lines.

32. When the rubber plants have reached some size they are liable to be suppressed by the trees left standing between the lines, which prevent their

lateral spread. As soon as this occurs these trees should be felled or girdled.

Rate of growth.

33. The measurements of 50 trees in each year's plantation (of 1874-75 to 1880-81) made during the years 1880-81 to 1897-98 are shown in Appendix I. They will give some idea of the rate of growth, which is very fast, of rubber trees in Charduar Plantation. The following measurements made in 1897-98 show the average height and girth of the trees in Kulsi Plantation :—

Plantation of	Average age.	Average height.	Average girth of central bole.
1873-77	22 years	88 feet	½′, largest 12¼′
1878	19 „	81 „	9′
1883	14 „	67 „	5′
1884	13 „	55 „	4½′

It will be seen that the girth is less, but the height greater than in Charduar Plantation. This is due to the trees being planted much closer together.

In 1899-1900 the girths and crowns of 10 per cent. of the trees tapped in Charduar Plantation were measured with the following results :—

Compartment.	Average age.	Number of trees measured.	Average girth.	Average maximum diameter of the crowns.
4	23 years	100	10·6′	64 feet
5	21 „	162	9·1′	61 „
6	21 „	95	7·4′	63 „
7	21 „	96	6·7′	61 „
8	21 „	77	6·2′	58 „

CHAPTER II.

ON THE TAPPING OF FICUS ELASTICA AND THE PREPARATION OF RUBBER FOR EXPORT.

Clearing the plantation lines.

34. Before the tapping operations commence all the undergrowth below the trees is cut level with the ground, so that bamboo mats can be spread to catch the latex which overflows from the cuts. A small path should also be cleared.

Clearing the trees of climbers.

35. At the same time all climbers which cover the trunks and branches of the trees must be cut so that they may be quite dead when the tappers come round.

Numbering the trees.

36. Each line of trees in each compartment should bear a number, the numbers starting from the principal road and the trees in each line should also be numbered serially. The following directions have been found necessary for the guidance of the officer in charge of the tapping operations. Every time the trees are tapped, the numbers should be painted over with coal tar; otherwise they soon disappear and no register of outturn from each tree could be kept up. Before starting the work the officer should walk along the block line at the end of the block and check the numbers on the last trees with the numbers in the register, *e.g.*, suppose the register shows 34 trees in a line, then the last tree should bear the number 34. When this has been done for all the lines, the officer should go again to the first line and see that each tree in the line bears its correct number. If there is any doubt, the register should again be consulted. When this has been done, the painting of the numbers can commence from tree number 1. When the first line has been done, the officer should walk back along the second line and check the trees as before, etc. It is essential that the old numbers on the trees should never be altered.

Fixing "pegs" to the trees.

37. The tapper before commencing to operate with the gouge is required to climb the tree he intends working and brush it down removing all dead twigs, climbers, leaves and other impurities which are likely to fall on the mats below, and at the same time every experienced tapper

affixes what are locally called "pengs," that is, pieces of green wood tied with split cane at right angles to the growth of the stem on all branches or boles which are difficult to hold on to when tapping, as both his hands must be free for the gouge and the mallet.

Tools used.

38. At present the cuts are made with a V-shaped gouge about 1¼ inches in greatest breadth. It is held in the left hand and a small wooden mallet in the right.

When tapping operations were started in 1898-99 "daos" and "khukries" or Assamese and Nepalese cutting knives were used, but this method resulted in inflicting gaping wounds which are still visible and it soon became evident that it was necessary for the future welfare of the plantation that some other implement should be employed. Experiments were then made with various other tools and of those the V-shaped gouge was found to be the best because the depth of the cuts made with this instrument can be to some extent regulated and the wounds also heal rapidly.

Method of tapping.

39. The tree being prepared the tapper climbs up to the highest branch it is intended to tap. He then gouges out the bark by giving horizontal cuts on alternate sides of the branch, taking care to remove only the bark without injury to the wood, but unfortunately this is not always done, the cambium layer is severed and the wound takes longer to heal. The interval between the cuts should be 15 inches, which is the length of the gouge, and each should extend more than half and less than two-thirds round the circumference of the branch or bole. No branch less than 2 feet in girth should be tapped.

Methods formerly employed.

40. In 1898-99, the year in which tapping operations were started, the system adopted was to make the cuts regularly one foot apart down the stem of the trees, these cuts being horizontal and not exceeding 8 inches in length and 2 inches in width. Aerial roots and branches less than a foot in girth were not tapped. It was afterwards found that no fixed rule can be laid down and that the experienced Nepalese tappers make the cuts 2 feet and often more apart and the length of the cuts varies with the girth of the bole. Again, they avoid making the cuts immediately one below the other and locate them alternately. The position of the cuts appears to have more effect on the yield than their number. In the

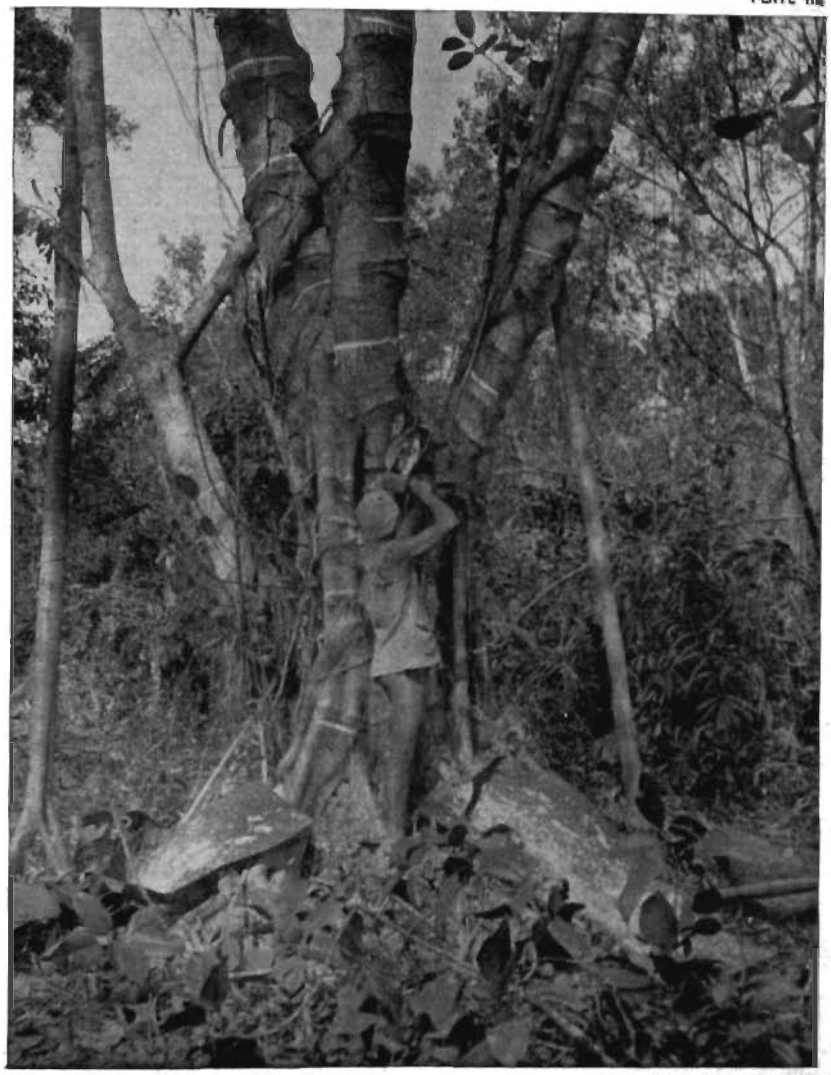


Photo-Mechl. Dept., Thomason College, Roorkee. E. M. Coventry, Photo

METHOD OF TAPPING.

following year further experiments were made. The cuts were made horizontal or only slightly oblique, it being noticed that the wounds bled in proportion to their horizontal direction and that any considerable deviation from this direction resulted in a slower and reduced flow of rubber. Experiments on untapped trees were made with the view of testing this point; arrow-shaped (the Brazilian method), oblique, as well as horizontal cuts being made, when it became apparent that the latex flowed far more freely from the last than from either of the others.

Occurrence of the latex.

41. The latex occurs in the bark and in the leaves. It seems safe to assert that the rubber cells are placed in more or less vertical rows when it will be readily understood why a horizontal cut must be much more effective in tapping their contents than a vertical or oblique cut of equal length.

Flow of the latex.

42. The latex exudes from the surfaces of the cut bark and some of it overflows and falls to the ground, but after two to three minutes the flow ceases and the remainder of the latex coagulates in the cuts. When dry it is stripped off the tree and when this is done a milky and sometimes copious residuum runs from the wound down the tree. It has been ascertained that this liquid contains no caoutchouc and is capable of being absorbed by blotting paper or of being evaporated in the sun; that, in fact, it consists of little else than water.

In March the latex becomes of a watery nature and a large proportion of it which spurts out of the wound and is collected on mats evaporates leaving no trace.

Collection of mat rubber.

43. Formerly the overflow was collected from the ground after it was dry and was called "ground rubber," but lately bamboo mats have been spread under the trees to catch this overflow. Ordinary bamboo mats $5' \times 2\frac{1}{4}'$, which cost from 1 anna to $1\frac{1}{2}$ annas each, are used for collecting the overflow of latex from the cuts. These mats are first well dried in the sun for a week, for if green bamboo mats are used the rubber becomes discoloured and black, and for this reason for the last two years a strong solution prepared by boiling down 1 part of rubber bark (cut into small strips) in 60 parts of water for 5 hours, is smeared over each mat before use in order that the mat rubber might obtain the same red

tint which the rubber derives from contact with the bark. As there has been little or no difference in the price of the coloured and uncoloured rubber, it is proposed to discontinue this practice and, instead, give every matman six well-dried mats, which he spreads out on the ground one by one, watching the drip of the latex from the cuts as they are being made.

The latex of the Ficus Elastica being very viscid only flows for about three minutes after the cut has been made: as soon as the drip from the cut ceases the mats are struck on the back with a stick to throw off strips of bark and other impurities which may have fallen from above and thus the same six mats may be used over and over again until they are thickly coated with coagulated latex. Any impurities seen imbedded in the latex are removed at once and the mats are then be put out in the sun, and when dry enough, (generally after two days), the rubber is pulled off and after picking and cleaning is weighed in at the godown and at once given out to women for further hand picking. At the close of each day's work all the mats in use are put in the sun for a short time to dry and are then carefully put away under shelter from the dew and rain. Each mat will ultimately carry a sheet of rubber from three to five pounds in weight, but as soon as the mats turn black they should be thrown away. Small tins and mats have been hung below the cuts to catch the latex, as an experiment, but the system has been abandoned as being too expensive.

Collection of tree rubber.

44. Generally on the third day after the cuts have been made (the time depending on the weather) the latex which has remained in the cuts is dry enough to be pulled off the tree. It should be kept in long strips and on no account be rolled up into balls for if the tappers are allowed to roll up the rubber, stones, bark and other impurities will be found inside the balls. As a tapping register is kept up showing the yield of each individual tree separately, the rubber after collection from the cuts has to be weighed at the foot of the tree and thereafter the whole of one day's collection is taken to the godown and re-weighed.

Cleaning the rubber.

45. Immediately after weighment it is given out to women to be hand-picked and cleaned. The longer rubber is left uncleaned the more difficult is it to work, as the impurities are held by the drying rubber and have

ultimately to be cut out. Tree rubber is divided into two classes "A" and "B" which are separated by the women when cleaning. Class A contains only the rubber which is collected from the cuts. Class B contains the rubber which runs from the cut down the branch or bole of the tree and not being coloured by the sap from the cut bark remains white or grey like the mat rubber.

The mat rubber is classed as "C" rubber.

Drying the rubber.

46. The three classes of rubber are kept separate in the godown spread out on shelves put up for the purpose. The sheets of mat rubber are hung up on cords stretched across the godown. Every morning, as soon as the fog lifts and the sun is bright, all the rubber is put out in the sun for a quarter of an hour and then replaced on the shelves.

Class A rubber should after drying in this manner for ten days be ready for packing, and the same applies to B rubber; but class C rubber is kept for a month before being packed.

Pressing the rubber.

47. When the rubber is quite dry 1 cwt. is weighed out and by means of screw pressure is converted into an 18-inch cube. After 24 hours it is ready for packing.

Packing the rubber.

48. The packing is done with country cotton cloth which by means of thorough washing has been deprived of all starch and other facing. After re-weighment the package is then sewn into a double gunny bag, the number and the weight of the rubber is stencilled on it and it is ready for export.

Season for tapping.

49. The best season for tapping is the cold weather from about the middle of October to the end of March. The yield is greatest from the middle of November to the middle of January, *i.e.*, when the growth of the trees is at the minimum. The colder the weather, the greater the outturn is said to be; but settled weather is essential, for if rain occurs within two days of tapping, part of the latex is washed away and the loss is heavy, while what remains on the stems loses in elasticity and becomes brittle and discoloured, and after some days of continuous rain it turns black in the same way as mat rubber, if washed, also turns black. Most rubber is yielded in the early morning. As the temperature rises the yield decreases and is at its lowest in the

evening. In cloudy weather the yield is said to be greater than when it is sunny.

Age of tapping.

50. The age at which the trees should be tapped is not exactly known, but it depends mainly on their size. It is known that the yield of small trees (say up to 3 or 4 feet in girth) is in the Assam plantations very small so that it hardly pays to tap them; but this may not be the case under other conditions than those obtaining at Charduar and Khulsi.

Interval between tappings.

51. It seems probable that rubber trees cannot be tapped every year without permanent injury but that they require at least one year's rest. Gamble ("Manual of Indian Timbers") states that "the tree will not bear yearly tapping, once in three years is as much as it will stand; if tapped yearly, it is liable to die off, as did many of the trees in Darjeeling after heavy tapping in 1871, 1872 and 1873. Those which then survived had not recovered sufficiently for retapping by 1880, and I have not heard of their having been tapped since then."

Twenty-one selected dominant trees in compartments 2 and 3 of Charduar plantation were tapped for three years in succession, *viz.*, 1896-97, 1897-98, and 1898-99 and yielded 46, 48 and 9 lbs. of rubber, showing a great falling off in the third year. Compartment 4 was also tapped for three years in succession, *viz.*, in 1898-99, 1899-1900 and 1900-01. In the third year only 100 trees were tapped, as there was a great falling off in the yield. Fifty trees were tapped by the method of opening the old cuts and 50 by making fresh incisions between the old cuts. The following figures show the result of tapping the 50 trees by the method of opening the old cuts:—

	Yield in		
	1898-99	1899-1900	1900-01
	lbs. oz.	lbs. oz.	lbs. oz.
50 trees	55 7	42 4	14 8

These figures, as a whole, may be taken as conclusively proving that the tapping of trees three years in succession by the system of re-opening the old cuts is a failure. Under the system of retapping by making fresh incisions between the old cuts, the following figures show the total yield of the 50 trees so operated on for three years in succession :—

	Yield in		
	1898-99	1899-1900	1900-01
	lbs. oz.	lbs. oz.	lbs. oz.
50 trees	43 0	35 13	24 1

There was a considerable falling off in the third year.

Trees have also been tapped twice during the same season, as an experiment, but at the second tapping the yield has been about 50 per cent. less than at the first.

Further experiments extending over some years are required before it can be known definitely at what intervals the trees should be tapped, but it seems probable that tapping cannot proceed every year, unless it is very lightly done. Part of Compartment No. 7, of Charduar plantation, has been tapped in 1905-06 after one year's rest and shows a large falling off in yield, whilst Compartment No. 1, of Kulsi plantation, tapped after an equal interval, shows a small increase. But the Deputy Ranger who has been in charge for three years considers the quality of rubber inferior to that previously obtained. Consequently it would appear that a rest for two years after tapping is required, but further experiments are necessary before any definite decision is arrived at.

52. The following figures show the outturn per acre and per tree in clean and dried rubber for the compartments tapped up to date at Charduar plantation :—

Outturn of rubber, Charduar plantation.

Compartment No.	Yield per acre in lbs. in							Yield per tree in lbs. in						
	1898-99.	1899-1900.	1900-01.	1901-02.	1902-03.	1903-04.	1904-05.	1898-99.	1899-1900.	1900-01.	1901-02.	1902-03.	1903-04.	1904-05.
1	8·6	...	...	27·7	...	...	30·9	0·5	...	...	1·6	...	..	1·8
2	9·0	...	...	34·4	...	...	35·0	0·5	...	...	1·9	...	...	2·0
3	11·3	...	...	30·5	...	...	36·9	0·7	...	...	1·9	...	...	1·8
4	9·7	9·1	6·1	...	22·6	...	...	0·6	0·6	0·4	...	1·4	...	...
5	...	9·2	..	...	20·4	...	...	...	0·6	...	...	1·4	...	...
6	...	11·5	...	...	22·4	...	...	...	0·8	...	...	1·5	...	...
7	...	10·4	...	...	...	23·6	...	...	0·8	...	...	...	1·8	...
8	...	8·9	...	...	...	25·2	...	...	0·7	...	...	...	1·9	...
9	...	...	8·0	...	...	15·8	...	...	...	0·7	...	...	1·5	...
10	...	...	11·2	...	...	...	25·0	..	...	0·9	...	...	...	2·1
11	...	...	6·4	...	...	...	17·5	...	...	0·4	...	...	...	1·2

It will be seen that there has been a large increase at the second tapping. The percentage of mat rubber in 1904-05 on the whole outturn was 26·8 per cent. The loss in cleaning and drying amounts to $3\frac{1}{2}$ per cent., that of tree rubber being 3 per cent. and that of mat rubber 5 per cent.

The largest yield from a single tree in 1905-06 was 7 lbs. 15 oz.

In the report for 1874-75 it is stated that, if tapping is commenced in the branches, most rubber will be obtained from them; if in stem, from the stem. This requires proof. The branches are said to yield more rubber than the stem. In 1899-1900 and the previous year, the crowns of 10 per cent. of the trees tapped were measured, and it was found that the outturn of rubber was in proportion to the spread of the trees, those with the largest crowns yielding most.

53. The Kulsi plantation, started in 1873, has an area of 153·6 acres. It has been divided into two blocks. Block A, area 80 acres, consisting of compartments 1 to 4, had an average age of 32 years in 1905-06 and

Outturn of rubber, Kulsi plantation.

Block B, the remainder of the plantation, area 65·6 acres, of 28 years. The trees were first planted 100′ × 25′ apart. A few years later the spacing was altered to 50′ × 25′ and finally it was decided to plant 25′ × 25′. The yield of rubber is given below :—

Block or Compartment.	Planting distance.	Yield per acre in lbs.						Yield per tree in lbs.					
		1900-01.	1901-02.	1902-03.	1903-04.	1904-05.	1905-06.	1900-01.	1901-02.	1902-03.	1903-04.	1904-05.	1905-06.
C 1	50×25	27·1	...	...	44·1	...	48·06	1·1	...	...	1·6	...	1·8
C 2	50×25	28·0	...	...	44·2	,,	...	1·1	...	...	1·7	...	...
C 3	50×25	29·0	...	...	45·0	...	,,	1·0	...	...	1·6	...	...
C 4	50×25	29·4	...	...	42·2	...	...	1·1	...	...	1·5	...	...
Plantation 1878	50×25	...	57·4	...	...	61·0	...	...	...	...	...	2·3	...
,, 1883 Block I.	25×25	...	21·8	...	...	30·9	...	...	...	...	...	1·1	...
Plantation 1883 Block II.	25×25	...	30·1	...	...	30·4	...	...	...	...	...	0·5	...
Plantation 1883 Block III.	25×25	...	47·0	...	...	57·8	...	...	...	...	...	0·6	...
Plantation 1884	25×25	...	21·8	...	...	31·9	...	...	...	...	...	0·5	...

Analysis of rubber.

54. A sample of Charduar plantation rubber was analysed by the Reporter on Economic Products and gave the following results :—

—	Calculated on material as received per cent.	Calculated on material dried at 1000 C. per cent.
Caoutchouc (tree rubber)	76·67	77·47
Resin	19·2	19·3
Albuminoid matter	1·5	1·5
Dirt and insoluble matter	1·7	1·7
Moisture	0·9	...
Ash included in dirt	0·5	0·5

It was noted that the rubber contained comparatively small quantities of albuminoid matter, dirt and moisture and that so far as these constituents are concerned no objection can be taken to its quality. The amount of resin present is abnormally high, the quantity of this material usually found is the rubber of Ficus elastica being from 3 to 7 per cent. This high percentage appears to be a constant feature of rubber produced in the Charduar plantation, a sample

previously examined at the Imperial Institute having been found to contain 18 per cent. No precise data are available to show how the composition of the rubber of Ficus elastica varies with the age of the trees from which it is obtained, and it would probably be of interest to examine samples of Charduar rubber from time to time in the future in order to determine whether the amount of rubber decreases as the trees mature or whether it is independent of age and due possibly to climate or other external causes inducing a change in the composition from that obtained from the branches.

Analysis of bark and leaves.

55. Twenty-five lbs. each of bark and leaves were collected and after drying in the sun for three days the samples were forwarded to the Imperial Institute for analysis with the following result.

Bark.—"The bark was in the form of narrow strips, about one inch wide, which had evidently been obtained in tapping operations. On breaking these strips there was little evidence of the presence of rubber in the bark, as only in a few cases were any threads of caoutchouc visible.

The rubber present in the bark was estimated by extracting with hot chloroform and precipitating the concentrated solution by the addition of alcohol. In this way 0·7 per cent. of caoutchouc-like material was obtained from the bark, but it is of very poor quality as it possessed little elasticity or tenacity and hardened on standing.

Leaves.—"The leaves were quite dry and brittle, and when treated in the same manner as the bark no caoutchouc or caoutchouc-like material could be extracted from them."

It is noted that better results might have been obtained by working with fresh material and that it would have been better to have dried the specimens in the shade than in direct sun light. Also that the latex present in the leaves of rubber trees is often of a very resinous nature and the product might be of very little commercial value.

Cost of tapping operations.

56. In 1904-05 the cost of tapping operations at Charduar amounted to Re. 0-6-10 per pound of clean, dry rubber. The cost includes that of clearing the rubber lines, purchase of mats, cloth, gunny bags and gouges, erection of temporary huts, tapping, cleaning, drying, packing, cartage to Tezpur, colouring the mats and making of wooden presses, etc. The rubber was sold for Rs. 2-11-0 per lb. delivered at Tezpur.

57. When operations were started in 1898-99 the cuts were coal-tarred. This was found unnecessary and has been discontinued. The cuts, especially those made with the V-shaped gouge, heal rapidly.

Coal-tarring the cuts.

58. During the first three years the crown and girth measurements of 10 per cent. of the trees were taken, sal pegs being driven into the ground to mark the crown measurements and a coal-tarring to show where the girth of the trees had been taken. These measurements besides being entered in a book were struck on to a large zinc label which was affixed to the trees. The report of 1899-1900 states that the girth measurements of the trees are difficult to make in a uniform manner, owing to aerial roots which form supplementary stems having a tendency to anastomose, that the figures under this head may be ignored : and the report of the following year that after considering the question of these crown measurements on the ground it was decided that in no single instance would any two persons agree in the measurements taken. It may, however, be accepted as an axiom that the greater the leaf canopy, the larger the root system and the greater the yield of the tree. After this year the measurements were discontinued.

Measurements of girth and crowns of the trees.

59. The practice of tapping the roots of rubber trees is often carried on illicitly in the forests. It is most destructive and often kills the trees. It might be prevented by imposing a very high duty on root rubber which can be easily distinguished from the rubber obtained from other parts of the tree. This proposal is at present under consideration.

Root tapping.

60. At first "mikirs," who are said to be the best tappers in Assam, were employed on a daily wage of eight annas per day. Nepalese and local Assamese were also engaged and paid Rs. 30 and Rs. 20, respectively, per maund of rubber collected. At present Garos and local Assamese are employed. They are paid annas four per pound of rubber collected. It is necessary that the men should be good climbers, since they have to use both hands when tapping the trees. Each tapper is accompanied by a boy, his son or some near relative, so that both tappers and matman have the same interest in the cleanliness of the mat rubber. One matman is able to move the mats of two tappers who are working at the same tree, but one matman cannot attend to two men who are tapping different trees.

Labour employed.

NOTE BY S. EARDLEY-WILMOT, INSPECTOR-GENERAL OF FORESTS.

THE information embodied in this pamphlet comprises what has been learnt in Assam regarding the plantation of Ficus elastica there, but the financial statistics of these plantations would form no guide to the planter who commences operations with 30 years of departmental experience to guide him, and they have therefore been omitted.

2. It may, however, be stated that it would cost about Rs. 20 per acre to stock that area with rubber trees whether large seedlings are put out at from 16 to 20 to the acre or a greater number of smaller transplants. The cost of preparing the plantation for the reception of the plants would vary with the locality; where virgin forest or swampy ground has to be dealt with the expenditure would naturally be higher than if neither of these drawbacks were present, involving expensive clearances or the construction of mounds. In any case the maximum cost of preparation should not be more than Rs. 20 or Rs. 30 per acre, bringing up the total to Rs. 40 or Rs. 50 per acre stocked with young plants.

3. It appears to me personally that where damage from wild animals is not to be anticipated it might be preferable to put out younger plants about 30 to 50 to the acre, so that probably after a very few years these would by their shade keep the undergrowth in check and future expensive cleanings would be unnecessary. It also seems to me that the tapping of such a fully stocked plantation could be commenced much earlier than at 25 years of age, probably at 12 or 14 years; the yield would not be large per tree but would amount to a considerable weight per acre although the cost of collection would probably run rather high.

4. The question of the greatest yield per acre, based on the number of trees on that area, must be made the subject of careful enquiry, for it is obvious that a point must be reached when the yield from a large number of smaller trees would be equal or more than that from a few larger stems. Meanwhile all we know is that at 20 to 25 years of age an acre of plantation containing 16 to 20 trees will yield about 35 lbs. of rubber every third year; and that there is every reason to surmise that

in the previous five to ten years it might have yielded one-third that amount and would in the following ten years give a larger quantity. Whether this increase will continue for many further terms of ten years and whether the planter should, to obtain this advantage, maintain or reduce the number of standards per acre is unknown.

5. The yield of the Assam plantations is extremely small; we read that in Java on a plantation of 72 acres, on which were planted 5,200 trees, tapping commenced at 14 years of age and that after 7 years work the outturn per acre per annum was 71 lbs. of rubber. At Charduar the outturn of 23 to 25 years old trees is about one-sixth of that amount, and this justifies further enquiry as to the method and recurrence of tapping operations. It appears probable that if the latex could be collected without subjecting the tree to such extensive bark injuries the outturn could be very largely increased. It is possible that the vitality of the tree suffers from the removal of such a large percentage (about 4 per cent.) of its bark during each tapping operation and that this, and not so much the flow of latex, renders yearly tapping impossible. This is a subject on which more knowledge is required.

6. The rubber of Assam contains so large a proportion of resin (19 per cent.) that its commercial value is considerably diminished. It may be sold, as during the current year, at the railway, four miles away, at Rs. 3 per pound on the total outturn of good, bad and indifferent, but this leaves a wide margin on the 6*s*. per pound given in London for fine Para biscuits. We require some further knowledge of the demands of the tree in soil, climate and locality and their influences, if any, on the proportion of resin in the latex and on the outturn of rubber; and as the finest natural rubber trees are found on the well drained slopes of the sub-tropical hills we may have doubts whether the production of the best rubber is feasible in localities which for weeks of the year are either covered with water or are subject to repeated inundations of a less permanent nature as is the case at Charduar and Khulsi.

7. Finally the cost of collection might probably be reduced, and as this now amounts to 4½ annas per pound in the plantations, where there is no undergrowth, to 7 annas per pound in other localities less favourably situated, this subject will also doubtless repay further investigation. In this regard the comparative cost of tapping many smaller or a few larger trees will have to be considered, the physical labour and danger being greater in the latter case.

APPENDIX I.

Height growth in feet.

Age in years.	Charduar Plantation. Plantation of 1874-5.	1875-6.	1876-7.	1877-8.	1878-9.	1879-80.	1880-1.	Average.	Bamoni Hill plantation of 1874-5.
1							7·36*	7·36	
2						10·17	9·80	9·98	
3					16·36	12·50	13·66	14·17	
4				21·07	19·0	17·41	15·69	18·29	
5			24·69	24·58	23·31	19·85	20·08	22·50	
6		26·87	28·50	29·41	25·41	23·91	24·58	26·45	
7	31·26	29·25	32·25	30·27	30·16	29·75	28·66	30·23	
8	32·75	34·41	34·17	34·75	33·83	34·83	32·0	33·82	
9	37·66	36·36	38·16	40·75	37·58	38·25	38·58	38·19	
10	40·06	40·08	46·83	44·83	42·16	44·0	43·33	43·04	
11	43·33	44·58	47·91	48·50	46·16	48·41	46·83	46·53	
12	49·0	49·83	52·25	53·75	49·41	52·08	47·83	50·59	36·5
13	53·25	52·33	55·83	57·0	52·25	53·08	50·16	53·41	40·58
14	55·83	57·50	61·16	60·75	53·25	54·16	55·75	56·91	42·91
15	61·91	61·41	63·83	61·75	55·41	60·75	59·91	60·71	47·25
16	64·33	64·75	64·91	64·08	59·75	63·25	64·08	63·59	55·41
17	66·75	65·83	67·66	68·83	63·16	66·41	65·33	66·28	58·83
18	67·91	68·91	71·66	72·16	65·08	67·41	68·0	68·73	60·75
19	71·08	73·08	75·08	73·41	69·16	70·83		72·11	62·91
20	74·75	76·0	77·66	74·91	71·58			74·98	69·66
21	77·33	77·58	80·41	78·41				78·43	73·66
22	78·0	81·58	80·91					80·16	77·08
23	83·25	83·66						83·45	80·50
24	85·0							85·0	84·16

* These must have been three or four years old when planted out.

Average annual increase in height for Charduar plantation

$$\frac{85 - 7{\cdot}36}{23} = 3'{\cdot}38.$$

Bamoni Hill plantation

$$\frac{84{\cdot}16 - 36{\cdot}5}{12} = 4'{\cdot}01.$$

APPENDIX II.

Circumference growth in feet.

Age in years.	Charduar plantation. Plantation of							Average.	Bamoni Hill plantation
	1874-5.	1875-6.	1876-7.	1877-8.	1878-9.	1879-80.	1880-1.		of 1874-5.
1							0·26	0·26	
2						0·35	0·42	0·38	
3					0·67	0·58	0·66	0·64	
4				0·99	1·0	0·83	0·98	0·95	
5			1·26	1·58	1·08	1·20	1·83	1·39	
6		1·28	2·0	1·75	1·55	2·41	1·91	1·82	
7	1·76	2·08	2·08	2·19	2·41	3·33	2·58	2·35	
8	2·66	2·08	2·38	3·75	3·33	3·83	3·50	3·05	
9	2·66	2·84	4·75	3·91	3·41	3·91	4·16	3·66	
10	3·55	4·58	4·91	4·25	4·08	5·16	4·83	4·48	
11	5·41	6·25	5·0	5·33	4·50	5·66	4·83	5·28	
12	8·91	6·78	6·91	5·91	5·75	6·58	5·50	6·52	
13	9·0	7·33	7·41	6·66	6·91	6·66	5·58	7·08	
14	10·66	7·83	8·16	7·9	7·0	6·75	6·25	7·77	
15	11·41	9·16	9·08	7·83	7·16	7·58	7·41	8·52	10·83
16	12·16	9·83	9·16	7·91	8·0	7·75	8·91	9·10	12·41
17	13·66	10·0	9·25	8·16	8·25	10·66	11·41	10·20	13·29
18	13·83	10·08	11·0	8·50	8·91	12·33	12·16	10·97	14·16
19	13·91	11·08	12·0	11·08	11·16	13·25		12·08	14·33
20	15·75	12·41	12·16	12·83	11·50			12·93	15·58
21	16·75	14·91	14·08	13·75				14·87	15·91
22	18·0	16·16	14·91					16·36	16·0
23	18·91	20·75						19·83	16·25
24	23·16							23·16	16·91

Average annual increase in girth

$\frac{23{\cdot}16 - 0{\cdot}26}{23}$ = 0·99 feet for Charduar plantation.

$\frac{16{\cdot}91 - 10{\cdot}83}{9}$ = 0·68 feet for Bamoni Hill plantation.

The measurements were apparently made over the aerial roots.

APPENDIX III.

Areas, etc.

Compartment.	Area in acres.	Number of lines.	Number of trees.	Years in which opened.	Year in which planted.	Year in which replanted.	REMARKS.
1	66·07	29	1,108	1873-4	1873-4 1878-9		In 1879-80 trees interplanted so as to be 25' apart.
2	73·48	36	1,209	Do.	1873-4 1878-9		
3	79·80	42	1,225	1874-5	1875-6		Do.
4	94·31	43	1,521	1874-5	1875-6		Do.
5	126·84	41	1,859	1876-7	1876-8		
6	77·25	40	1,112	Do.	1876-8		Do.
7	80·39	38	1,062	Do. & 77-8	1876-9		Do.
8	73·73	37	978	Do. & 77-8	1876-9		
9	87·80	30	946	1878-9	1881-2		
10	76·30	29	772	Do.	Do.		
11	94·9	30	1,413	1882-3	1882-3		Seedlings were planted on forks of trees over 30 acres in 1883-5.
12a	98·30	20	943	1888-9	1888-9	1892-3	
12b	(61)	18		1897-8 1895-6	1897-8 1895-6		
12c	50	10	494	1903-5	1903-5		
13	29·59	24	The plants have not been counted lately.	1884-5	1884-5		
14	65·43	16		Do.	Do.		
15	115·0	56		1884-5 1888-9	1884-5 1890-1	1892-3	
16	299·0	91		1889-90	1890-1	1892-3	
17	102	36		1890-1	1890-1 1891-2	1892-3	
18	407·4	116		1891-2 1892-7	1892-7		
19	262·5	92		1899-1900	1899-1900		
20	364·7	76		1900-1	1900-1 & 01-02		
21	23·06	2½		Do.	Do.		
Total	2747·85						

APPPENDIX IV.

Area statement.

Year.	Compartments opened or planted.	Areas added.	Other alterations in area.	Area at close of year in acres.
1873-4	1 and 2	180	...	180
1874-5	...	...	...	180
1875-6	3 and 4	140	...	320
1876-7	5 (part or whole), 6 (part), 7 (part)	110	...	430
1877-8	5 (part), 6, 7 and 8 (parts)	143	...	573
1878-9	1 (part), 2 (part), 7 (part), 8 (part)	112	...	685
1879-80	9 and 10	118	...	803
1880-1	...	...	...	803
1881-2	...	...	...	803
1882-3	11	89	...	892
1883-4	Seedlings received in forks of trees in compartment 12.	...	...	892
1884-5	13 and 14	120	...	1,012
1885-6	15 (part) or 14 (part)*	31	..	1,043
1886-7	...	...	...	1,043
1887-8	..	...	...	1,043
1888-9	12 *a* and 15 (part)	63	...	1,043
1889-90	15 (part) and 16	432	...	1,538
1890-1	17	225	...	1,763
1891-2	...	..	...	1,763
1892-3	18	300	...	2,063
1893-4	18	41	...	2,104
1894-5	...	...	...	2,104
1895-6	12*b*	20	41*c*	2,165
1896-7	18	12	— 518*a*	1,659
1897-8	12*b*	41	...	1,700
1898-9	Potasali block	40	...	1,740
1899-1900	19	180	+ 278*b* + 98*c*	2,296
1900-1	20	80	+ 193*c*	2,569
1901-2	20	271	...	2,840
1902-3	21	13	...	2,853
1903-4	12*c*	10	— 40*d*	2,823
1904-5	12*c*	40	— 117*a*	2,746

a = disforested.

b = reafforested.

c = corrections of area.

d = Postasali block abandoned.

* *c*14 according to the annual report, but the area of *c*13 and 14 is only 95 acres and 120 acres were planted last year.

APPEN

Statement showing the outturn of Rubber

Compartment.	Area in acres.	Area tapped.	Year.	Number of trees tapped.	OUTTURN					
					Tree Rubber.			Mat Rubber.		
					Gross.	Nett.	P. c. of loss in cleaning.	Gross.	Nett.	P. c. of loss in cleaning.
1	66·1	66·1	1898-99	1,149	...	...	...	...	...	...
		66·1	1901-02	1,133	1,250	...	...	635	...	...
		66·1	1904-05	1,107	1,616	1,565	3	501	476	5
2	67·7	67·7	1898-99	1,174	...	...	...	...	...	...
		67·7	1901-02	1,228	1,549	...	...	830	...	...
		67·7	1904-05	1,220	1,790	1,735	3	737	697	5
3	75·3	75·3	1898-99	1,212	...	...	...	...	...	...
		75·3	1901-02	1,216	1,553	...	...	806	...	...
		57·6	1904-05	930	1,314	1,271	3	373	358	4
4	94·3	94·3	1898-99	1,514	...	...	...	...	...	...
		94·3	1899-1900	1,499	...	...	...	...	...	...
		...	1900-01	100	...	...	...	...	...	...
		94·3	1902-03	1,488	1,487	1,464	1½	692	672	3
5	126·8	126·8	1899-1900	1,849	...	...	...	...	...	...
		126·8	1902-03	1,866	2,093	2,068	1	544	524	3½
6	77·25	77·25	1899-00	1,116	...	...	...	...	...	...
		77·25	1902-03	1,112	1,428	1,411	1	340	323	5
7	80·39	80·39	1899-1900	1,060	...	...	...	...	...	...
		80·39	1903-04	1,062	1,436	1,377	4	541	522	3½
		...	1903-04 Do. 2nd tapping.	52	37	35	5	9	8	11
8	73·73	73·73	1899-1900	980	...	...	...	...	...	...
		73·73	1903-04	978	1,443	1,407	2½	470	447	5
		...	1903-04 Do. 2nd tapping.	50	30	28	6½	8	8	...
9	87·8	87·8	1900-01	953	...	...	...	...	...	...
		87·8	1903-04	946	1,116	1,082	3	318	307	3½
		...	1903-04 Do 2nd tapping.	50	26	25	4	8	8	...
10	66·9	66·9	1900-01	808	681	...	...	67	...	...
		66·9	1904-05	772	1,172	1,131	3½	505	483	4
11	94·9	94·9	1900-01	1,495	555	...	...	49	...	...
		94·9	1904-05	1,413	1,171	1,135	3	555	522	6
2 Nursery.	5·8	5·8	1901-02	756	...	...	...	...	...	...
		5·8	1904-05	?	50	47	...	16	16	...
		5·8	1904-05 Do. 2nd tapping.	?	27	27	...	10	9	...
		...	...	...	77	74	4	26	25	4
3 Nursery.	4·5	4·5	1901-02	315	...	...	...	...	...	...
		4·5	1904-05	?	114	110	3½	40	38	5
10 Nursery.	9·4	9·4	1904-05	?	129	124	4	28	26	7

DIX V.

from the Charduar Rubber Plantation.

IN POUNDS.

TOTAL.			PER ACRE.						PER TREE.					
			Tree rubber.		Mat rubber.		Total.		Tree rubber.		Mat rubber.		Total.	
Gross.	Nett.	P. c. of loss in cleaning.	Gross.	Nett.	Gross.	Nett.	Gross.	Nett.	Gross.	Nett.	Gross.	Nett.	Gross.	Nett.
611	576	5½	...	...	...	...	9·2	8·6	...	...	...	...	0·5	0·5
1,885	1,836	2½	18·9	...	9·6	...	28·5	27·7	1·1	...	0·6	...	1·7	1·6
2,117	2,041	3½	24·4	23·7	7·6	7·2	32	30·9	1·5	1·4	0·4	0·4	1·9	1·8
655	607	7	...	...	...	...	9·7	9·0	...	...	...	...	0·6	0·5
2,379	2,328	2	22·9	...	12·3	...	35·2	34·4	1·3	...	0·7	...	2·0	1·9
2,527	2,432	4	26·4	25·6	10·9	10·3	37·3	35·9	1·5	1·4	0·6	0·6	2·1	2·0
902	848	6	...	...	...	...	12·0	11·3	...	...	...	...	0·7	0·7
2,359	2,295	3	20·6	...	10·7	...	31·3	30·5	1·3	...	0·7	...	2·0	1·9
1,687	1,629	3	22·8	22·1	6·5	6·2	29·3	28·3	1·4	1·4	0·4	0·4	1·8	1·8
1,042	916	12	...	...	...	...	10·1	9·7	...	...	...	...	0·7	0·6
912	863	5½	...	...	...	...	9·7	9·1	...	...	...	...	0·6	0·6
...	39	...	...	...	...	...	...	6·1	...	...	...	...	...	0·4
2,179	2,136	2	15·8	15·5	7·3	7·1	23·1	22·6	1·0	1·0	0·5	0·4	1·5	1·4
1,243	1,176	5½	..	...	...	...	9·8	9·3	...	...	...	...	0·7	0·6
2,637	2,592	1½	16·5	16·3	4·3	4·1	20·8	20·4	1·1	1·1	0·3	0·3	1·4	1·4
940	889	5½	...	..	..	...	12·3	11·5	...	...	...	...	0·8	0·8
1,768	1,734	2	18·5	18·3	4·4	4·2	22·9	22·5	1·3	1·3	0·3	0·3	1·6	1·6
882	833	5½	...	...	...	...	11·0	10·4	...	...	...	...	0·8	0·8
1,977	1,899	4	17·9	17·1	6·7	6·5	24·6	23·6	1·4	1·3	0·5	0·5	1·9	1·8
46	43	...	...	...	...	...	...	...	0·7	0·7	0·2	0·1	0·9	0·8
694	657	5	...	...	...	...	9·4	8·9	...	..	...	...	0·7	0·7
1,913	1,854	3	19·6	19·1	6·4	6·1	26·0	25·2	1·5	1·4	0·5	0·5	2·0	1·9
38	36	5	...	...	...	...	...	...	0·6	0·6	0·2	0·2	0·8	0·7
...	749	...	...	...	...	...	...	8·5	...	...	...	...	...	0·8
1,434	1,389	3	12·7	12·3	3·6	3·5	16·3	15·8	1·2	1·2	0·3	0·3	1·5	1·5
34	33	3	...	...	...	...	...	...	0·5	0·5	0·2	0·2	0·7	0·7
748	...	...	10·2	...	1·0	...	11·2	...	0·8	...	0·1	...	0·9	...
1,677	1,614	4	17·5	16·9	7·5	7·2	25·0	24·1	1·5	1·5	0·7	0·6	2·2	2·1
604	..	...	5·9	...	0·5	..	6·4	...	0·4	...	...	...	0·4	...
1,726	1,657	4	12·3	12·0	5·9	5·5	18·2	17·5	0·8	0·8	0·4	0·4	1·2	1·2
80	79	1	...	...	...	...	13·8	13·6	...	...	...	...	0·1	0·1
66	63	...	..	..	...	...	..	...	...	...	...	...	...	...
37	36	...	...	...	...	...	...	...	...	...	...	...	...	...
103	99	4	13·3	12·7	4·5	4·3	17·8	17·0	0·1	0·1	...	...	0·1	0·1
20	20	...	...	...	...	...	4·4	4·4	...	...	...	...	...	...
154	148	4	25·3	24·5	8·9	8·4	34·2	32·9	0·4	0·4	0·1	0·1	0·5	0·5
157	150	4	13·7	13·2	3·0	2·8	16·7	16·0	...	...	...	...	...	...

G. I. C. P. O.—No. 47 R. & A.—28-5-1906.—1,000.—H. R.

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ON

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1. *Distribution.*—Sâl is the principal forest tree in Bengal, and occurs in greater or less abundance in all of the Bengal Government forests, with the exception of the maritime swamp forests in the Sundarbans and of the hill forests of the Darjeeling district, which are over 3,000 feet in elevation.

Thus it occurs in places with greatly differing soils and climate, and the various kinds of localities in which it grows may be conveniently divided into four types, *viz.*—

(*a*) *Very favourable localities*, where the soil is deep, fresh and fertile from a forest point of view and the rainfall is considerable or heavy, say 60 inches to 200 inches a year; such are (*i*) the sâl-producing areas in the Kurseong terai and on some of the most favourable slopes in the Tista valley, (*ii*) the valley type areas in Singhbhum, and (*iii*) the high lying valleys, elevation 1,100 feet to 1,500 feet, in Angul.

(*b*) *Favourable or fairly favourable localities*, where though the summer is hot and dry and the rainfall is only moderate, 45 inches to 65 inches, whilst the surface soil is often shallow, other conditions, such as fertility, the absence of frosts and permeability of the sub-soil are favourable; for instance, half valley type and a considerable part of the hill type areas in Singhbhum, the bulk of the sâl-producing areas in the central parts of the Angul reserves, the southern forests in Puri and Sambalpur, and most of the Sonthal Parganas

sâl forests. Though they are subjected to heavier rainfall and differ in some other respects, the bulk of the sâl-producing areas in the hill forests of Darjeeling may be included in this type.

(*c*) *Unfavourable localities*, where most conditions are as for type (*b*), but either the surface soil is unfertile from a forest point of view or the sub-soil is impervious; for instance, the Northern Puri and Sambalpur forests, most of the low-lying plains and valleys in Angul, and parts of the hill type areas in Singhbhum.

(*d*) *Unfavourable localities*, where, other conditions being as for type (*b*) or type (*c*), severe frosts from time to time occur; for instance, nearly the whole of the sâl-producing area in Palamau and Hazaribagh.

As, within limits, the fertility of the soil from a forest point of view varies with the treatment it receives, the above distinctions are not in all cases of a permanent character. Under good management some localities of type (*b*) may improve to such an extent that it may become possible to regard them as of type (*a*), and so on.

2. *Production of flowers, seed and seedlings.*—Sâl flowers more or less profusely almost every year. The flowers begin to appear in March just after or just before the fall of the last of the leaves of the previous year, and the new crop of leaves appears just after or along with the flowers. The maturing of a good crop of seed is, however, often prevented by unfavourable weather, and only one year in three, about, is a really good seed year.

Sâl seed ripens and falls to the ground in June or July. When it falls in wet weather the seed germinates in a few days, but when its fall is followed by a long continued drought, all or almost all of the seed dries up and fails to germinate. In continuously wet weather some of the seed may germinate before it falls from the parent trees.

Sâl seed which falls in favourable weather appears to germinate freely in all places except those where the soil is covered with a very dense undergrowth. But in dry localities where the soil is poor and there is little or no shelter from the sun all or nearly all of the seedlings die very rapidly, whilst in a damp climate the combined effects of a fairly complete tree canopy and of an undergrowth of shrubs or herbaceous plants prove equally destructive. But even in relatively dry tracts, when rainfall is well distributed and the

soil is completely or partially sheltered by trees or undergrowth, numbers of seedlings survive their first cold weather and the following summer and, if subsequent conditions are favourable to their development, in the end grow into saplings and trees. In the damp tracts, sâl seedlings are more likely to suffer during their first year from excessive shade either of the tree canopy or of the undergrowth, or from both, than from exposure and drought. But even in these tracts seedlings survive in considerable numbers in all but the wettest or shadiest places for more than a year.

In dry tracts it usually happens that, to begin with, the above-ground parts of sâl seedlings die down during the cold weather or summer, whilst the roots retain their vitality and send up new shoots when the next rains begin, and in many places this dying down of the upper parts and putting forth of new shoots by the roots must be repeated annually for a number of years before the plants can acquire sufficient strength to send up shoots which can persist through a hot weather. But this drying up of the upper parts appears to be the exception in the Terai, and it is probably far from universal in other localities of type (*a*).

When sâl seedlings have been kept alive for one year their subsequent development depends on various conditions. In a relatively dry climate they nearly everywhere tolerate a fairly heavy shade, whilst they benefit from a certain amount of cover, such as is supplied by an interrupted canopy of trees or a light undergrowth, till they are well established saplings 8 feet or 10 feet high. In the hottest situations they bear and benefit from a fairly complete cover. But in damp climates, for instance in the Terai, any complete cover is destructive to sâl seedlings over 1 or 2 years old; and though seedlings will in many cases survive for many years under a moderately dense shade, they in such conditions make very little upward growth and gradually lose their vitality. In fact, it is probably the case in the Terai that shade can be only useful to sâl seedlings over 1 year old in an indirect manner, *i.e.*, by helping to keep down weeds and creepers; and as some of the last described plants stand shade better than sâl seedlings, this indirect use of shade does not always benefit the latter.

3. *Rates of growth and exploitable sizes.*—In dry localities sâl seedlings may take 10 years or more to form persistent shoots, and 20 years or more from the time of germination to become established saplings 8 feet or 10 feet high. But in the Terai when sâl seedlings are not kept back by shade or creepers, and if other conditions are

favourable, they should be 9 inches to 18 inches high when they are 2 years old, and they should become well established saplings 8 feet to 10 feet high in 6 to 10 years.

Having reached this stage the growth of the plants till they attain a girth of about 3 feet should be rapid or fairly rapid, whether the climate is damp or dry. But much depends on the quality of the soil and immediate surroundings, such as the presence or absence of overhead shade or creepers and the density of the crop. So far as can be ascertained from existing sample plots the period necessary for such a sapling to grow into a tree 3 feet in girth ranges from 20 to 30 years in the Terai to 80 or 90 years in localities of types (*c*) and (*d*) which are not exceptionally unfavourable.

The average girth increment of trees which are between 3 feet and 6 feet or 7 feet in girth varies greatly. In the case of trees growing in exceptionally unfavourable positions in localities of type (*c*) or (*d*) this increment may be reduced to insignificance before a girth of 4 feet is attained, and trees placed in slightly less unfavourable conditions grow very slowly indeed whilst their girth increases from 3 feet to 4 feet 6 inches or 5 feet, and they generally begin to decay before attaining a girth of 6 feet. But leaving out of consideration these exceptionally unfavourable places, the girth increment at this stage may be said to vary from a third to half an inch a year in localities of types (*b*), (*c*) and (*d*) and from six-tenths to one inch or over in localities of type (*a*). Thus in the best parts of the Terai trees may attain 6 feet in girth in 50 to 60 years, exclusive of the time required for the growth of a sapling 8 feet to 10 feet high. In the valley type areas in Singhbhum the corresponding period probably varies between 100 and 140 years, whilst in ordinary localities of type (*b*) it probably varies between 140 and 180 years. In ordinary localities of types (*c*) and (*d*) it is probable that only a small proportion of the trees attain girths of 6 feet or over, and that trees which do attain such a girth are usually over 200 years old.

The above remarks only apply to well grown trees which have reasonable or ample space for the development of their crowns. Suppressed or partly suppressed trees grow very slowly indeed, even in favourable localities. In the Bhamanpokri sample plot in the Terai, there are suppressed trees of which the yearly girth increment during 25 years has averaged less than a tenth of an inch. In considering the sizes to which sâl trees should be allowed to attain before they are felled, it is necessary to take into account

risks of decay. As a rule in localities of type (*a*) few trees decay before they attain 7 feet in girth and many trees attain girths of 9 feet or over before they begin to decay. But in localities of type (*b*) most of the trees begin to decay before they attain a girth of 7 feet, whilst in localities of types (*c*) and (*d*) decay generally sets in before a girth of 6 feet is attained. These remarks are based on observations of crops which during the greater part of their existence have suffered from frequent fires and other abuses. It is possible or probable that trees grown in crops which are well protected throughout their existence will be liable to decay at comparatively early ages. Decay is greatly helped by slow growth or want of vigour which has in the past often been due to fires, overgrazing and the like.

4. *Methods of treatment of crops grown from seed.*—Like most other kinds of trees sâl produces the best timber when it is grown in forests or complete groups. Though, as has been shown, more or less cover is useful or necessary for the establishment of a crop of sâl saplings, after this stage has been reached cover is generally harmful. In most places groups consisting of about equal aged or equal sized saplings, poles or trees, that is to say, regular groups, are preferable to irregular groups in which the component trees are of widely differing sizes or ages. In regular groups sâl may be grown pure, that is, by itself or mixed with other suitable species. But in either case, to obtain the best possible results, the crop should at all stages be complete without being dense enough to prevent a reasonable development of the crowns of the trees which compose it. So far as is known the density of the canopy should be greater in the earlier stages, that is, till the trees are 2 feet 6 inches or 4 feet in girth, according to the locality, than in the later stages of the crop; for poles or young trees support density better than older trees, and density in the early stages secures the early death and fall of the side branches, and the formation of long boles of clean timber free of knots. It is believed that thinnings of this kind should usually begin when the dominant poles are 1 foot 6 inches to 2 feet in girth, when the number of stems should be 250 to 300 to the acre, and should be continued at intervals of 5 to 15 years till the trees are 4 feet to 5 feet, or 3 feet to 4 feet in girth, according to the locality and the exploitable size or age adopted. From this stage, till the crop is nearly ready for regeneration, it probably pays to give the trees which are expected to form the final crop a greater amount of room; but care should always be exercised

to avoid making large holes in the canopy and encouraging the establishment of a dense undergrowth, such as would greatly interfere with regeneration. So far as can be judged from incomplete observations, the number of stems should be reduced to about 200 to the acre when the trees are 2 feet to 2 feet 6 inches in girth, 60 or 70 to the acre when they are 4 feet to 5 feet in girth and about 40 to the acre when they are 6 feet to 6 feet 6 inches or 7 feet in girth.

The treatment of mixed, regular crops containing a considerable proportion of sâl should be very similar, but in many cases it is desirable that in these thinnings should begin at an earlier stage to prevent the suppression of sâl by inferior species which have a more rapid rate of growth, and the thinnings should always bear on the inferior species rather than on sâl. But the inferior species should not be thinned out to such an extent as to seriously interrupt the canopy.

In short, sâl forests, grown from seed, from which it is desired to obtain the largest possible yield of timber of a high quality, should be managed under the regular method. Actually all sâl forests in Bengal which are managed with a view to the production of large trees are worked under the selection method or under improvement fellings. This is necessary, as the crop is generally mixed and irregular. The supply of large-sized sâl trees is comparatively small and consists of trees scattered throughout the forests, most of the existing trees of large sizes being of species other than sâl, for which there is little demand. In these circumstances attempts to regenerate compact blocks of large sizes would necessitate the cutting of large numbers of trees of inferior kinds, which could not be disposed of, and of immature sâl trees, and would therefore result in serious losses. It is at present sought to improve the crop of sâl by uncovering and keeping free from creepers young growth of sâl wherever found, trees of inferior species which are suppressing sâl being sold if purchasers can be found for them or cut or girdled, and an outturn of sâl timber is in the meantime obtained by the cautious cutting of the largest sized or defective sâl trees in selection or improvement fellings. It is hoped that this treatment will eventually lead in most places to the establishment of more or less regular groups of sâl to which the regular method, or something closely resembling that method, can be applied.

For the selection fellings a minimum exploitable diameter of 2 feet, or girth of 6 feet, has usually been adopted, and the fellings

are so regulated that the stock of exploitable trees may be kept up or more than kept up. With fellings so regulated it should not generally be necessary to fell sound trees which are still promising till they are 6 feet 6 inches or 6 feet 9 inches in girth. In some forests, in fact in nearly all localities of types (*c*) and (*d*) and in some localities of type (*b*), there is reason to believe that such a minimum exploitable size will be found to be excessive. Comparatively early decay or an early falling off in the girth increment will probably make it undesirable to attempt to grow in such forests trees with girths exceeding 4 feet, 4 feet 6 inches, or 5 feet as the case may be. But forests of this kind are at present so abnormally stocked that accurate study of their possibilities is impracticable. In the Terai it may eventually be found desirable to raise the minimum exploitable girth to 7 feet or even 7 feet 6 inches.

5. *Coppice.*—So far only the production and treatment of sâl trees which have been raised from seed and are managed with a view to the production of heavy timber have been considered. Besides reproducing itself from seed sâl coppices well, at least outside very damp localities, that is to say, saplings and young trees less than 40 years or so old, when cut within a foot or 6 inches off the ground, send out coppice shoots, which usually leave the parent stem below ground level and rapidly form independent root systems. When a well established seedling, half an inch or so in diameter, is cut back, the resulting shoot grows with only ordinary rapidity, attaining a girth of about 6 inches in 10 years, and is soon indistinguishable from any other seedling, and except that their growth in the first few years is usually more rapid, coppice shoots from the stumps of saplings 1 inch to 2 inches or even 3 inches in diameter are very similar. But coppice shoots from the stumps of poles or small trees up to 8 inches, or in some cases 1 foot in diameter, usually possess characteristics which distinguish them from trees grown from seed throughout their existence. Coppice shoots from such stumps have a very rapid rate of growth to begin with. In the first year they attain heights of 6 feet to 10 feet, and by the time they are 10 years old the leading stems are usually a foot or over in girth. It is believed that from about this point the girth increment falls off to a very marked extent, especially on a poor soil, and so far as is known the period necessary to grow, from coppice, poles about 1 foot 9 inches or 2 feet in girth varies between 20 and 30 years, according to conditions. Coppice shoots of this description do not usually grow into good trees of large size. From the time they attain girths ranging from 2 feet to 4 feet, according

to circumstances, they appear to grow more slowly than seedling trees of equal ages, and they appear to be more subject to early decay than the latter. It was at one time supposed that sâl trees of coppice origin did not produce fertile seed. But this appears to have been a mistake. Reproduction from coppice cannot be utilised to any great extent except in places where the nature of the demand or of the soil, or of the climate makes the production of small poles and firewood the chief object of management. On this account coppice-felling of sâl forests in Bengal is restricted to a few localities where the exploitable age or felling rotations adopted vary between 16 and 30 years. Wherever it has been introduced this kind of management is recent and is actually a conversion of more or less irregular forests into coppice. In these circumstances the forests to which the method is applied are not very suitable for coppicing, sâl trees of the most suitable sizes for coppicing, *i.e.*, 1 foot to 1 foot 6 inches or 2 feet in girth, being comparatively scarce. But seedlings are generally abundant, and though shoots from these seedlings are not likely to attain useful sizes in the first rotation, by the end of it most of them should be capable of putting forth, after they have been cut back, very strong coppice shoots.

Thus, by the end of the second coppice rotation all of these forests should be very well stocked for the application of the coppice system, and the yield of the coppice fellings should show a marked increase.

Accurate observations to show when sâl trees begin to lose the power of coppicing have not been carried out, but there is no reason to suppose that any marked loss of such power occurs before the trees or coppice shoots are 30 years old. When sâl trees instead of being cut at or near ground level are felled so as to leave stumps a foot or more in height, shoots mostly begin on the top of the stump and generally fall when this stump decays.

In the dampest parts of Bengal, *i.e.*, in the Terai and in the Tista valley, sâl is a bad coppicer.

6. *Fire-protection and its results.*—In Bengal fire has been the principal cause of injury to sâl forests; but the effects of fire on sâl differ widely in accordance with local conditions, much depending on the age and condition of the trees, the amount of inflammable material present on the ground and on its relative dryness. In a complete crop of sâl (trees over 2 feet in girth) when there is little inflammable material except a moderate covering of fallen leaves, a single fire can do very little damage, especially if it occurs early in the dry season or when, owing to comparatively recent rain,

the material in question is not at its most inflammable stage. But even under such favourable conditions repeated fires must generally lead to the impoverishment of the soil and to a reduction of the girth increment, and they must also greatly increase risks of premature decay. Where inflammable material abounds a single fire, occurring in the middle of the hot weather, causes lasting injury to all or most of the large-sized trees and kills down to the roots all or most of the small-sized ones. In sâl coppice only one year old, practically all of the shoots are destroyed by almost any fire, and one year's growth is lost. As the coppice grows older its liability to damage from fire decreases, especially if the production of inflammable material is kept down by grazing, fodder-cutting, etc. And usually sâl coppice which is over three years old can, if the production of inflammable material is kept down, be burnt early in the spring, as the leaves fall, without immediate, noticeable injury. Possibly when coppice which is worked for the supply of small sticks or poles, 5 to 10 years old, is burnt in this way the production of wood is not adversely affected. But such burning must nearly always tell severely on the quality and amount of the outturn where it is sought to grow large coppice, 20 to 30 years old. Generally it may be remarked that the effects of fire to some extent depend on local conditions. In fresh situations where the soil is fertile from a forest point of view sâl trees may attain large sizes without becoming unsound, and reproduction may continue in a fashion in spite of frequent fires. Some observers, drawing their deductions from observations of exceptionally well situated areas, have come to the conclusion that fires are not harmful to sâl forests. But the incorrectness of such a conclusion is well-illustrated by the results of a careful examination of the Singhbhum reserves, which was carried out by Mr. Haines from 1902 to 1904. Up to about 1884 these forests had been burnt, whenever they became dry enough to burn, but except in places which had been *jhumed* and in a few relatively small areas which contained particularly good trees, practically nothing had been cut in them before this examination. Fire protection had been attempted between 1884 and 1902, but had not been very successful. Mr. Haines found that out of 442,649 acres:—

(*a*) 20,650 acres, or about 5 per cent., was stocked with well-grown trees or had till recently contained well-grown trees;

(*b*) 32,768 acres, or about 7 per cent., contained a crop of moderately grown sâl trees which were considered to be to a large extent unfit to yield timber for export;

(*c*) 21,192 acres, or about 5 per cent., consisting of areas which had been previously cultivated, contained more or less promising young growth of sâl, of which the establishment had been largely due to partially successful fire-protection in the previous 20 years;

(*d*) 314,303 acres, or 71 per cent., only contained a very scattered crop of ill-formed and more or less unsound sâl trees of great ages but of small or moderate sizes, such advance growth as existed being entirely the result of fire-protection.

In (*a*) resistance to fires has been greater than in other parts of the forests, as the soil is comparatively fertile and as, owing to their greater freshness, areas containing growth of this type were less inflammable than other parts of the forests. Still the crop of sâl found growing on these areas was very far from perfect, and the total amount of sound timber obtained from them has probably not been more than half of the amount they would have yielded if they had been continuously fire-protected. Under fire-protection the reproduction of sâl in these areas has greatly improved, and a promising young growth of sâl is establishing itself in most of the other parts of the forests; and it is already clear that this new crop will be of quite a different class to the original one. In fact, whilst protection from fire is nearly everywhere essential for the development of sâl seedlings into sound, well-formed trees of large sizes, so far as is known fire-protection can only be harmful to sâl in an indirect manner, that is to say, through the help it gives to creepers and other competitors and enemies of sâl.

7. *Competitors of sâl.*—So far as is at present known, the growth of inferior species of trees and creepers, which follows the successful fire-protection of sâl-producing forests which are not completely canopied, is a serious obstacle to the establishment of a young crop of sâl only in places where the rainfall is very heavy, *i.e.*, 100 inches a year or more, or where, though the rainfall is moderate, other conditions are exceptionally favourable to a profuse growth of all kinds of forest plants or weeds. Elsewhere, though the places where creepers do not sooner or later require to be checked appear to be the exception, and the cutting or destruction by other means of trees of inferior species which either dominate young sâl-trees or reproduction of sâl, or take up space in the canopy which is required for the development of the crowns of about equal sized sâl trees, is from time

to time necessary, such operations are of a simple and cheap kind and the necessity of carrying them out is a very minor drawback in comparison with the benefits derived from fire-protection. In the dampest places, that is to say in the Terai, the greater part of the sâl-producing area in the hills of the Darjeeling district, and even in the most fertile valleys in Angul, the profuse growth of trees of inferior species, weeds and creepers which follows successful fire-protection is a very serious obstacle to the reproduction of sâl. Though it is a general rule that in most localities of this description fire-protection in the first instance favours the establishment of reproduction of sâl, after a time, if nothing except fire-protection is attempted, the growth of other plants becomes so profuse that any additional sâl seedlings which come up are choked, and many or most of the sâl saplings or poles which established themselves in the early days of fire-protection succumb to creepers. It is now being sought to ascertain whether the tendency, under continuously successful fire-protection, of the inferior kinds of plants to exterminate sâl in this way can be counteracted by any practicable system of cleaning, weeding and creeper-cutting. The point is to discover whether with the help of such operations, repeated every year till the young sâl is out of danger, the sâl seedlings which still make their appearance in fair numbers can be enabled to grow up into a crop of promising saplings and poles. When a canopied crop, which mainly or entirely consists of such saplings or poles, is formed, the risk of destruction by inferior kinds of trees, weeds and creepers is greatly lessened if it is not altogether removed. Whilst it is admitted by nearly all foresters that if forests of this description are allowed to be burnt indiscriminately, as they were burnt before they were fire-protected, good results cannot be obtained, it is supposed by some that burning might be regulated in such manner as to be made a means of keeping in check the competing plants without permitting the fires to put a stop to the establishment of sâl seedlings and their development into promising poles; and it is possible that experience will prove that this opinion is correct so far as certain descriptions of ground are concerned. But trustworthy experiments in the regulated use of fire to assist the reproduction of sâl have not been carried out, and there is reason to believe that, in the Terai at least, such experiments would not be successful unless they were accompanied by improvement fellings of a more or less arduous and costly nature, whilst they would necessarily lead to a considerable amount of injury to the existing crop of sâl.

Hence in the Terai it is sought to improve the reproduction of sâl by making improvement fellings or cleanings, and weeding the seedlings which are uncovered by, or come up after such fellings every year till they are out of danger. Experiments have not yet gone far enough to show for how many years such weeding will be necessary, but it is supposed that the period will vary between 4 or 5 and 7 or 8 years. Anyhow, the advance growth of sâl which is established by means of such operations will not be out of danger from suppression by weeds and creepers till it forms a canopied crop. In experiments of this description it has been found that suppressed and ill-formed sâl saplings after they are uncovered by the cleanings or improvement fellings take long to recover their vigour, and that it is very difficult to save them from being choked by creepers. In drier climates it is always desirable to cut back such saplings to ground level that they may be replaced by vigorous coppice shoots. But in the Terai they coppice so indifferently that it has not yet been proved to be advantageous to cut them back.

It is possible that continued fire-protection will, by encouraging the growth of competing plants, have the effect of making the reproduction of sâl difficult in many places where up to date fire-protection has been entirely beneficial to this reproduction; and it is desirable that the effects of fire-protection in all sâl forests should be the object of continuous observation, that early steps may be taken to counteract any unfavourable tendencies to which it may give rise.

8. *Creepers.*—In regard to creepers it may be observed that though these pests are at their worst only in the dampest localities, they give more or less trouble in nearly all fire-protected sâl forests, and they also sometimes cause a considerable amount of harm in forests which are not fire-protected. They directly damage seedlings and trees of all sizes by strangling or suppressing them, and they indirectly damage the crop by occupying a larger or smaller proportion of the available space in the canopy. A continuous war must be waged against creepers in nearly all sâl forests. To begin with, it is usually difficult to do more than work over the forests of a Division in the course of a few years cutting creepers which are damaging sâl trees. But when the most urgent work of this kind has been accomplished it is generally desirable to work through the forests again, cutting all large creepers, on whatever trees they may be growing, with the object of helping a dense canopy of trees to form and preventing the seeding of creepers. Nothing checks the growth of creepers more effectively than the formation of a dense

tree canopy. It is not sufficient to cut creepers once. The stumps of the cut creepers usually coppice, or fresh creepers take the places of those which die after being cut, especially in places where the canopy is light or interrupted. Creeper-cutting must generally be repeated at intervals which vary between 3 to 5 years in damp, ten years or more in comparatively dry localities, and it is probable that it will be found necessary to continue the operation at such intervals in most sâl forests in Bengal till they become completely canopied. This is apart from creeper-cutting which may be necessary as part of the weeding or cleaning required to help reproduction or advance growth of sâl in areas which are under regeneration. Such advance growth requires light which also encourages the growth of creepers. Up to the present this growth of creepers in areas which have been partially or wholly cleared for regeneration has been remarkable only in some localities of type (*a*) where it supplies one of the principal arguments for yearly weeding till the young sâl is well established. But it is quite possible that as the soil in other localities improves under protection, the damage occasioned in them by creepers to young sâl will tend to increase.

9. *Grazing.*—So far as is known the grazing of kine and sheep is not directly harmful to sâl except when it is in the small seedling stage, when cattle tread down and destroy, but do not usually eat up, the seedlings. Grazing is indirectly injurious to sâl forests as, when it is heavy enough, it results in the hardening of the soil and a loss of its forest fertility. Though, where other conditions are favourable, considerable numbers of sâl seedlings establish themselves in forests which are lightly or moderately grazed, in heavily grazed forests sâl seedlings are nearly always rare, and where other conditions are unfavourable a moderate amount of grazing may suffice to practically stop the reproduction of sâl from seed. Coppice reproduction of sâl is much less easily damaged by cattle than reproduction from seed and, if the crop which is coppice felled is suitably stocked for the purpose, even heavy grazing does not necessarily prevent the formation of a satisfactory crop of coppice poles. But when a coppice crop is open to grazing from the outset the coppicing of many stumps, which are either too old or too young to coppice vigorously, is nearly always prevented; hence in forests managed under the coppice system which are continuously open to grazing the density of the crop and the production of wood tend to decline. The closure of each coupe for 3 to 6 years, according to circumstances, after its coppice felling, does much to assure the permanency of the crop. But such an amount of closure cannot

everywhere ensure the establishment of sufficient numbers of sâl seedlings for the replacement of stumps which die without coppicing. No experiments appear to have been carried out for determining the effects of the deterioration on the soil, through grazing, on the rate of growth or increment in crops of sâl poles or trees which are too large to be directly injured by cattle. But general observations seem to point to a conclusion that the rate of growth is thereby materially lessened. Usually one of the most serious consequences of grazing is that the practice leads to forest fires, as the herdsmen are often careless, and also as the burning of forest land is generally believed to improve grazing.

10. *Frost.*—Sâl is very sensitive to frost, but fortunately the only sâl forests in Bengal in which severe frosts occur are those of the Palamau and Hazaribagh districts. In these, sâl seedlings which establish themselves in depressions are repeatedly damaged or destroyed down to their roots by frost. Protection by the cover of larger trees sometimes helps to save them from damage. But in exceptionally cold winters, as in 1904-1905, frosts are intense enough to kill or damage small sâl trees which, on such occasions, afford little or no protection to young growth which they dominate. Owing to the repeated destruction of their side branches by frost, the sâl trees in many parts of the Palamau reserves have assumed peculiar and characteristic shapes.

11. *Insect pests.*—The caterpillars or larvæ of several kinds of insects damage sâl either by eating the leaves or by boring into the wood. The temporary loss of leaves from such cause, when it is anything like complete, usually leads to a temporary reduction in the rate of growth. The most common borer generally confines its attention to dead or fallen trees from which the bark has not been removed. But it sometimes attacks and kills green trees.

12. *Artificial reproduction.*—For various reasons this has received very little study. Owing to its rapid germination it is not easy to obtain sâl seed for this purpose, and owing to their long tap root and temperament sâl seedlings are difficult to transplant. Moreover in all the dryer localities, when artificially reproduced sâl can be saved from drying up, it is long before well established seedlings or saplings are produced, and in the damper localities it is difficult to save the seedlings from suppression. For all of these reasons, and as where conditions have been suitable little or no difficulty has been experienced in obtaining sufficient natural reproduction, it has not been thought necessary to give much attention to the artificial reproduction of sâl. But the importance of

the subject will probably increase as the forests develop. The most hopeful experiment made so far is one which was carried out in Puri in 1907, when small baskets, filled with earth, were placed under seed-laden trees, the seed being allowed to fall into and germinate in them. When these seedlings were a few inches high the baskets, with the seedlings in them, were put out in the places it was desired to plant.

13. *Products of sâl trees.*—Sâl is of course chiefly valuable for its timber. But the sap-wood rots rapidly under exposure and is often eaten by insects when it is not exposed, whilst the heart-wood does not display great resistance to exposure, and even when it is not exposed is apt to split and warp badly, unless it is well seasoned before it is put in use. Though the heart-wood of old trees is supposed to be superior in durability to that of young ones, the central parts of old trees which are quite sound are very liable to split in drying, and in sawing logs obtained from very old but sound trees into sleepers or other scantlings it is generally desirable to reject a central wedge 6 inches to 9 inches square at the thick end of the log. Green sâl poles, under 2 feet say in girth, are of very little real use for any purpose, as they contain very little heart-wood; but they are often preferred, especially for mine props, to poles of other kinds, which should prove more durable, probably on account of their straightness. On account of the large amount of sap-wood they usually contain, poles or ballahs from green sâl trees 2 feet 6 inches to 3 feet 6 inches or 4 feet in girth leave much to be desired. But poles or ballahs cut out of dead trees which have lost all their sap-wood but have not stood or lain long enough in the forests to have begun to decay are as a rule of excellent quality.

The quality of the sâl timber produced in the Darjeeling hills and also in the Terai differs considerably from that of the Chota Nagpur and Orissa sâl. The former is rather lighter, splits less, and is generally more durable than the latter. The Darjeeling or Terai sâl cuts into good planks as well as beams, railway sleepers and the like, whilst the Chota Nagpur and Orissa sâl does not usually make good planking. How far this inferiority is due to improper or inadequate seasoning is, however, questionable, for the timber appears to be quite satisfactory for boat-building.

Sâl yields a very good firewood and makes very good charcoal, but it is at present rarely possible in Bengal to dispose of parts of trees which will not yield marketable timber.

The bark of sâl can be used for tanning or for the preparation of tan extracts, but so far it has not been found possible to dispose of bark for such purposes from Bengal forests. The tree also yields a resin in which there was formerly a considerable trade. But as the yield of resin is small, and as the usual method of extracting it is to girdle and kill the trees which are tapped, its collection is not now permitted.

11. The above note contains statements that no doubt require verification, and it is hoped that such will be made by Forest Officers in Bengal. One of the chief objects of the author in writing the note is to draw attention to the lack of knowledge and the large field for enquiry that exists, and to encourage study of the local conditions of growth.

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Forest Bulletins previously issued.

No. 1. 1905 . A Note upon the "Bee-Hole" Borer of teak in Burma.

No. 2. 1905. . A Note on the Quetta Borer (*Æolesthes sartus*).

No. 3. 1905. . A Note on the Chilgoza (*Pinus gerardiana*) Bark-Boring Beetles of Zhob, Baluchistan.

No. 4. 1906. . The natutal growth and artificial propagation of *Ficus elastica* with a description of the method of tapping trees and of preparation of its rubber for the market.

No. 5. 1906. . A Note on a visit to some European Schools of Forestry.

MEMORANDUM

ON

MECHANICAL TESTS OF SOME INDIAN TIMBERS.

DURING the last three or four years the Forest Department has sent specimens of many Indian timbers to Sibpur Engineering College for mechanical testing. I have now tested about 100 pieces, out of nearly 500 received, and it appears advisable to give some account of the results obtained.

After some consideration I decided to limit the strength tests of each specimen to three, *viz.*, shearing along the grain, endwise crushing, and bending. Tests of stiffness have been made during the bending tests. Timber never fails in tension; and tests of transverse crushing do not give definite results, as the yielding is gradual. For the shearing tests a clamping block was made, after preliminary trials, designed to prevent the test piece from bending at the middle and ends, thus leaving it no alternative but to shear. In preliminary experiments this apparatus was found to give consistent results on test pieces of teak ranging in thickness from $\frac{1}{2}''$ to $2''$; but I adopted $1''$ as the standard thickness for all the tests given below.

The test pieces for crushing were about $2''$ square by $4''$ long, except in a few cases where the specimen sent was less than $2''$ thick. In every case the test piece was square in section and of length double the side of the square.

The bending tests were made on the full section of specimen sent, mostly about $3\frac{1}{2}''$ by $2''$ but more in many cases; and the span adopted

was 4′ between supports, the load being applied in the middle. The supports as well as the pressure foot are designed to avoid damage to the test piece by local crushing.

It is a familiar fact that the strength of timber depends considerably on its humidity: partly seasoned wood with 20% of moisture has only about ¾ of the strength of well-seasoned wood with 10% of moisture. Nearly all the present specimens have been seasoned indoors in the climate of Calcutta for two years or more, and are therefore on a fairly equal footing as regards seasoning. Two or three pieces which were tested for humidity were found to have about 10% of moisture, but it was not feasible to test all the specimens for this property.

In considering the results it is convenient to use teak as a standard of reference in comparison; and it will be seen that the strongest timbers have rather more than double the strength and stiffness of teak, while none on the list have less than half that of teak. To aid comparison with non-Indian timbers the highest results are here given from tests made on 87 specimens of wood grown in various British colonies, the tests being conducted by Prof. Unwin:—

Shearing 1·246 (Lignum vitæ, from Jamaica).
Crushing 5·96 (Sneeze wood, from Natal).
Bending 9·52 (Red milkwood, from Natal).
Stiffness 1,465 (Mora wood, from British Guiana).

Corresponding results from tests of 32 American timbers, carried out under the direction of the Government of the United States, may also be of interest in this connection. These again are the highest figures, but each is the average of many tests:—

Shearing 0·58 (Cedar elm).
Crushing 4·9 (Pignut hickory).
Bending 8·4 (Do.).
Stiffness 1,220 (Do.).

These results are all given in tons per square inch.

Comparing with the present results, it will be noticed that three of the Indian timbers break the record for shearing strength, two for crushing strength, and two for bending strength. One Indian timber is about equal in stiffness to the best American wood, and is surpassed by two in Prof. Unwin's list of 87.

With regard to the considerable differences in strength or stiffness for two or more specimens of the same kind of timber, these are not

due to experimental errors but to actual differences in the pieces tested. The accuracy of the results can be safely relied upon within 1% in the case of the strength tests and within about 5% in the figures for stiffness. This possible error in the stiffness is chiefly owing to want of exact proportionality between load and deflection for timber, which is never quite homogeneous and thus bends irregularly.

The strength is given in tons per square inch, and the stiffness is Young's modulus of elasticity in the same units. In this respect I have followed Unwin. For comparison with the co-efficient of bending strength "P" given in Gamble's "Manual of Indian Timbers" for some woods, the present results for bending strength should be multiplied by 1244; and the present figures for stiffness should be multiplied by 5·19 to compare with the corresponding data "E" in the same work.

For the identification of the timbers I am indebted to the Forest Officers who selected and despatched them. A specimen of each timber has been kept for reference.

			Shearing strength along the grain (tons per sq. in.).	Crushing strength along the grain (tons per sq. in.).	Bending strength (tons per sq. in.).	Stiffness, from bending tests, E. (tons per sq. in.).
1	Tectona grandis (*Teak*)	Pegu	0·600	3·19	4·16	570
2	Ditto	Do.	0·580	3·20	4·76	520
3	Ditto	Do.	0·571	2·80	5·40	575
4	Ditto	Do.	0·620	2·81	3·86	405
5	Shorea assamica	Lakhimpur	0·593	2·85	5·27	700
6	Dillenia indica	Kamrup	0·625	3·48	6·2	680
7	Ditto	Do.	0·663	3·09	4·4	635
8	Baccaurea sapida	Do.	0·553	3·15	5·13	630
9	Ditto	Do.	0·377	...	5·05	615
10	Ditto	Do.	0·567	2·71	4·13	515
11	Bischofia javanica	Do.	...	2·81	3·98	...
12	Ditto	Do.	...	...	3·67	380
13	Canarium bengalense	Do.	0·680	2·72	2·15	273

			Shearing strength along the grain (tons per sq. in.).	Crushing strength along the grain (tons per sq. in.).	Bending strength (tons per sq. in.).	Stiffness, from bending tests, E. (tons per sq. in.).
14	Canarium bengalense .	Kamrup . .	0·613	2·29	2·83	243
15	Bauhinia variegata .	Do. . .	0·576	1·78	2·44	235
16	Ditto .	Do. . .	0·670	1·90	(1·83)	(187)
17	Symplocos grandiflora .	Darang . .	0·482	1·63	2·35	371
18	Ditto .	Do. . .	0·424	1·48	1·77	224
19	Ditto .	Do. . .	0·710	2·07	3·92	367
20	Villebrunea appendiculata.	Do. . .	0·522	2·30	3·20	366
21	Ditto .	Do. . .	0·493	1·82	3·66	349
22	Ditto .	Do. . .	0·615	1·95	3·43	395
23	Casuarina equisetifolia (*Casuarina*).	Ganjam . .	1·075	4·39	6·00	900
24	Ditto .	Do. . .	0·693	4·13	7·57	930
25	Ditto .	Do. . .	1·240	4·20	6·05	1108
26	Sapindus trifoliatus .	N. Arcot . .	1·310	4·05	...	...
27	Ditto .	Do. . .	1·080	4·14	...	...
28	Ditto .	Do. . .	0·965	3·94	5·32	630
29	Pterocarpus santalinus .	Do. . .	2·000	6·64	6·47	780
30	Ditto .	Do. . .	1·550	5·44	4·72	740
31	Ditto .	Do. . .	1·440	6·95	7·57	900
32	Pterocarpus dalbergioides (*Padouk*).	Andamans .	1·150	4·87	5·57	650
33	Ditto .	Do. . .	1·310	4·00	5·03	844
34	Ditto .	Do. . .	1·050	4·09	4·43	600
35	Albizzia Lebbek (Bth.) .	Do. . .	0·835	4·50	6·62	767
36	Ditto .	Do. . .	1·030	4·28	5·43	707
37	Ditto .	Do. . .	0·866	4·04	5·65	730
38	Terminalia bialata .	Do. . .	1·070	3·74	6·90	900
39	Ditto .	Do. . .	0·792	3·78	7·70	964
40	Ditto .	Do. . .	0·862	3·69	7·34	950

			Shearing strength along the grain (tons per sq. in.).	Crushing strength along the grain (tons per sq. in.).	Bending strength (tons per sq. in.).	Stiffness, from bending tests, E. (tons per sq. in.).
41	Myristica Irya (Gaertn.)	Andamans .	0·878	3·78	7·62	880
42	Ditto .	Do. .	0·990	4·28	7·27	805
43	Ditto .	Do. .	0·642	4·57	7·35	870
44	Diospyros Kurzii (Hiern.)	Do. .	1·000	3·78	4·34	724
45	Ditto .	Do. .	0·990	4·24	5·19	795
46	Ditto .	Do. .	0·848	3·98	5·34	900
47	Murraya exotica . .	Do. .	1·230	4·55	7·00	753
48	Ditto .	Do. .	1·400	5·27	7·49	898
49	Ditto .	Do. .	1·490	4·47	6·09	688
50	Lagerströmia hypoleuca (Kurz.)	Do. .	0·592	3·49	4·52	617
51	Ditto .	Do. .	0·785	2·82	4·36	610
52	Ditto .	Do. .	0·752	2·67	4·30	490
53	Terminalia procera (Roxb.)	Do. .	0·528	4·12	6·35	690
54	Ditto .	Do. .	0·498	3·76	4·19	510
55	Ditto .	Do. .	0·940	4·54	8·84	892
56	Alphonsea ventricosa (H. F. & Th.).	Do. .	0·938	3·34	5·40	750
57	Ditto .	Do. .	0·543	3·91	7·71	900
58	Ditto .	Do. .	0·582	3·78	6·32	702
59	Artocarpus Lakoocha (Roxb.).	Do. .	0·925	4·88	6·82	902
60	Ditto .	Do.	0·715	4·34	5·65	780
61	Ditto .	Do. .	0·980	4·45	8·03	802
62	Calophyllum spectabile (Willd.)	Do. .	0·768	2·86	3·90	509
63	Ditto .	Do. .	0·625	2·61	4·49	516
64	Ditto .	Do. .	0·762	2·68	5·23	605
65	Calophyllum Inophyllum	Do. .	0·763	2·70	3·36	439
66	Ditto .	Do. .	0·700	2·93	4·83	490
67	Ditto .	Do. .	0·882	3·14	4·32	490

			Shearing strength along the grain (tons per sq. in.).	Crushing strength along the grain (tons per sq. in.).	Bending strength (tons per sq in.).	Stiffness from bending tests, E. (tons per sq. in.).
68	Podocarpus bracteata (Bl.)	Andamans	0·684	3·46	5·80	677
69	Ditto	Do.	0·803	3·62	6·46	740
70	Ditto	Do.	0·600	3·63	5·42	700
71	Mimusops littoralis (Kurz).	Do.	0·477	3·06	4·03	534
72	Ditto	Do.	0·820	3·82	6·31	750
73	Ditto	Do.	0·800	3·44	5·70	630
74	Mimusops Elengi (Linn.)	Do.	1·380	5·18	10·65	1,020
75	Ditto	Do.	1·220	4·92	10·00	1,106
76	Ditto	Do.	1·390	4·93	10·48	1,100
77	Mesua ferrea (Linn.)	Do.	0·876	6·60	12·18	1,300
78	Ditto	Do.	1·000	5·92	9·23	1,140
79	Ditto	Do.	1·160	6·52	10·93	1,180
80	Hopea odorata (Roxb.)	Do.	0·992	3·80	8·29	940
81	Ditto	Do.	0·737	4·32	7·32	950
82	Ditto	Do.	1·150	4·21	8·37	903
83	Bombax insigne (Wall)	Do.	0·398	1·79	3·32	490
84	Ditto	Do.	0·352	1·60	2·79	485
85	Ditto	Do.	0·488	2·01	2·68	440
86	Adenanthera pavonina (L.)	Do.	1·040	4·57	6·16	790
87	Ditto	Do.	0·900	4·43	...	...
88	Ditto	Do.	0·915	4·57	6·72	880
89	Artocarpus Chaplasha (Roxb.)	Do.	0·550	2·89	4·45	480
90	Ditto	Do.	0·600	3·30	3·13	401
384	Machilus odoratissima (Lalie.)	Darjeeling	0·555	2·05	3·47	530
385	Ditto	Do.	...	1·94	...	...
386	Ditto	Do.	0·596	2·50	4·02	594

			Shearing strength along the grain (tons per sq. in.).	Crushing strength along the grain (tons per sq. in.).	Bending strength (tons per sq. in.).	Stiffness, from bending tests, E. (tons per sq. in.).
387	Michelia excelsa (Magnolia).	Darjeeling .	..	...	4·21	500
388	Ditto .	Do. .	0·573	2·27	4·85	532
389	Ditto .	Do. .	0·316	2·75	...	...
390	Quercus lamellosa (Hill Oak).	Do. .	1·180	3·54	6·60	778
391	Ditto .	Do. .	1·025	3·13	4·75	..
392	Ditto .	Do. .	1·010	3·20	.	...
393	Bucklandia populnea (Pipli).	Do. .	...	...	4·25	618
394	Ditto .	Do. .	0·575	2·54	...	...
395	Ditto .	Do. .	..	..	4·90	...
396	Castanopsis Hystrix (Chestnut).	Do. .	0·810	2·57	...	...
397	Ditto .	Do. .	...	...	5·20	520
398	Ditto .	Do.			4·23	633

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Forest Pamphlet No. 9 Working Plan Series No. 3

TABLES SHOWING THE PROGRESS IN WORKING PLANS

IN THE PROVINCES OUTSIDE THE MADRAS AND BOMBAY PRESIDENCIES UP TO THE 31st DECEMBER 1908

WITH SPECIAL REFERENCE TO THE APPLICATION OF THE VARIOUS SYLVICULTURAL SYSTEMS

Compiled by

A. M. F. CACCIA, I.F.S., M.V.O., F.Z.S.,

Imperial Superintendent of Forest Working Plans and Imperial Sylviculturist.

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Contents.

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WITH SPECIAL REFERENCE TO THE APPLICATION OF THE VARIOUS SYLVICULTURAL SYSTEMS

INTRODUCTION.

THE area under the control of the Forest Department on the 31st December 1908 in the provinces of British India outside the Madras and Bombay Presidencies was reported to be 131,302,506 acres, or approximately 205,160 square miles: 20,369,009 acres, or 15·5 per cent., of this total area having been brought under systematic working in accordance with the provisions of regular sanctioned working plans.

In the tables, which form the substance of this pamphlet, these figures are analyzed. The total forest area corrected up to the 31st December 1908 is shown by Forest Divisions, together with full details regarding the areas for which working plans have been completed and sanctioned: the area dealt with by each working plan being classified according to the sylvicultural system adopted. In this place, it will be sufficient to briefly summarize the information contained in the tables.

The following statement gives by Forest Circles the areas brought under the control of sanctioned working plans up to the 31st December 1908 in the provinces outside the Madras and Bombay Presidencies : —

Province.	Circle.	Forest area in acres.					Area for which working plans have been prepared and sanctioned up to 31st December 1908.	Proportion of forest area under sanctioned working plans.
		Reserved.	Leased.	Protected.	Unclassed.	Total.		
							Acres.	Per cent.
Bengal .	...	2,710,587	...	1,787,792	...	4,498,379	3,256,393	72
United Provinces.	Eastern Circle.	1,357,830	...	2,729	18,928	1,379,487	1,161,853	84
	Western Circle.	1,160,399	100,399	16,757	7,446	1,285,001	1,237,807	96
	Total .	2,518,229	100,399	19,486	26,374	2,664,488	2,399,660	90
Punjab .	...	1,156,286	236,199	3,354,308	1,102,107	5,848,900	2,568,376	44
Lower Burma.	Tenasserim Circle.	3,256,232	...	...	17,004,781	20,261,013	1,143,887	6
	Pegu Circle	4,025,034	...	...	16,297,441	20,322,475	1 070,485	5
Upper Burma.	Southern Circle.	3,975,583	...	...	20,547,497	24,523,080	1,364,438	5
	Northern Circle.	3,372,545	...	...	15,012,338	18,384,883	24,320	·13
	Total .	14,329,394	...	...	68,862 057	83,491,451	3,603,130	4

Province.	Circle.	Forest area in acres.					Area for which working plans have been prepared and sanctioned up to 31st December 1908.	Proportion of forest area under sanctioned working plans.
		Reserved.	Leased	Protected.	Unclassed.	Total.		
							Acres.	Per cent.
Eastern Bengal and Assam.	...	4,195,841	...	2,507	14,511,311	18,709,669	706,786	4
Central Provinces including Berar.	Southern Circle.	4,878,909	...	...	...	4,878,909	3,782,203	78
	Northern Circle.	4,715,083	...	...	1,791	4,716,874	2,496,906	69
	Berar Circle.	4,485,818	...	...	...	4,485,818	1,400,769	31
	Total .	14,079,810	...	...	1,791	14,081,601	7,479,878	53
Coorg .	...	332,926	..	...	...	332,926	113,727	34
North-West Frontier Province.	...	151,279	...		...	151,279	151,279	100
Ajmer .	...	90,679	...	115	3,471	94,265	89,780	95
Baluchistan	...	179,469	...	...	...	179,469	...	...
Andamans	...	101,930	...	...	1,148,149	1,250,079	...	...
Grand Total .		40,146,430	336,598	5,164,208	85,655,260	131,302,506	20,369,009	15·5

The total area under the control of sanctioned working plans being thus equal to 20,369,009 acres, the following statement shows the allotment of this area to the various sylvicultural systems; as well as the proportion of the total area under each method of treatment—

Sylvicultural System.	*Area in acres.*	*Equivalent in square miles.*	*Percentage of total area under each sylvicultural system.*
Method of Clear Fellings by compartments.	24,517	38	·1
Method of Clear Fellings by strips	...	...	...
Uniform method . . .	112,702	176	·5
Group method	48,474	75	·2
Selection method . . .	6,614,034	10,334	32·5
Storeyed forest method . .	...	...	...
Simple Coppice	81,482	127	·4
Coppice with standards . .	1,617,052	2,527	7·9
Method of Improvement Fellings	5,210,501	8,141	25·7
Unregulated Fellings or Unworked	6,660,246	10,407	32·7
TOTAL .	20,369,009	31,825	100

With few slight exceptions, the method of clearances, the uniform, and the group methods have not so far been applied to any extent in any of the forests of India. The method of clearances has been attempted in the Darjeeling forests (Bengal) with remarkable success; and the uniform method has been found to be entirely suited to the Chir (*Pinus longifolia*) forests of the United Provinces to which it has been largely extended. Steps are also being taken to apply this method of successive regeneration fellings to some of the Sal forests of the Kumaun Division in the United Provinces; the Sal, being a species which would seem to be well adapted to this method of treatment in all the highest quality localities and where excessive frosts are not to be feared. The method is also to be given a trial in the Mohnyin pure teak forest of Upper Burma; and it is probable that it will be extended in the near future to the Terai Sal forests of Bengal.

The Coppice method, the Selection method and the so-called method of Improvement fellings are, however, the ones which have received their widest application in India. The former method is eminently adapted to all village forests and fuel reserves, where the object of management is

to produce small poles and brushwood for the use of the surrounding peasantry ; the standards moreover supplying the necessary shelter and seed, as well as a certain quantity of wood of larger dimensions.

Under the conditions usually prevailing in Indian high forests, when large areas have to be dealt with, where in a mixed forests only one species is marketable, where the crop is irregular and only trees of large dimensions are saleable, when owing to local conditions it appears to be dangerous or inadvisable to interrupt the cover, and when a trained establishment is not available, the selection method is generally indicated. When in addition the forest is in a ruined condition, the age-classes are badly represented, and the object of management is to remove the overmature, dead and dying trees, whilst allowing the younger age classes to grow up under favourable conditions, the so-called "*Method of Improvement fellings*" is prescribed : the latter method being also known as the "*Selection method by areas,*" combined with sylvicultural operations for the benefit of the principal crop.

The calculation of the possibility under the selection method has received considerable attention in India, and the methods employed have been fully set forth in a Note recently published in the Indian Forest Records.*

The forests dealt with in a regular working plan usually include areas which are unworkable, either on account of their inaccessibility or the unproductiveness of the ground ; or, on account of want of demand. Such areas are either closed to all working as "protection forests," or the small amount of usually inferior material required from them, to an extent far below the possibility of the forests, is removed under the general orders and supervision of the Conservator by means of operations usually described as "*Unregulated Fellings.*" It will be seen that a considerable area in many of the more remote forests, where only a few trees of the valuable species are exploitable, falls into this class.

The tables which follow are corrected up to the 31st December 1908. They will require to be revised from time to time as additional areas are brought under systematic working, or whenever owing to the expiry and revision of an existing plan, the method of treatment comes to be altered.

* The Selection System in Indian Forests as exemplified in working plans based on this system. By A. M. F. Caccia. Indian Forest Records, Volume I, Part IV.

Table I.

SHOWING THE PROGRESS MADE IN WORKING PLANS WITH SPECIAL REFERENCE TO THE APPLICATION OF THE VARIOUS SYLVICULTURAL SYSTEMS.

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
North-West Frontier Province.										NORTH-WEST
		Hazara . .	...	151,279	...	151,279	Kagan range forests	Deodar; Pinus longifolia; P. excelsa; Abies Webbiana; etc.	2	...
							Siran range forests	Pinus longifolia, P. excelsa; Abies Webbiana; etc.	2	...
							Dungagali and Tandiani range forests.	Oak; P. longifolia; P. excelsa; Deodar; etc.	4	...
							Khanpur range forests.	Pinus longifolia; Dodonœa Viscosa; Prinsepia utilis; Acacia modesta; A. catechu; Olea cuspidata; Pistacia intergerrima.	2	...
		GRAND TOTAL	...	151,279	...	151,279	...	..	...	...
Punjab.	Punjab.									PUN
		Rawalpindi .	Reserved .	160,100	51,195	211,295	Kalachitta Forests	Olive, Acacia . .	8	...
			Protected .	48,665	...	48,665				
			Unclassed	...	229,137	229,137	Murree-Kahuta Forests.	...	7	...
		Total .	...	208,765	280,332	489,097	...	...	...	...
		Kangra .	Reserved .	35,282	...	35,282	Kangra Forest Division.	...	7	14
			Protected .	473,378	...	473,378				
			Unclassed	278,237	...	278,237				
		Total .	...	786,897	...	786,897	...	...	...	...
		Kulu . .	Reserved .	42,981	..	42,981	Kulu Forest Division.	Deodar; P. longifolia; P. excelsa; Picea Morinda; Abies Webbiana; etc.	4	...
			Protected .	1,274,880	2,306	1,277,186				
		Total .	...	1,317,861	2,306	1,320,167	...	...	...	...
		Bashahr .	Leased .	145,920	90,279	236,199	Bashahr Leased Sutlej Valley Forests.	Deodar; Pinus excelsa; etc.	4	...
			Reserved .	...	417	417				
		Total .	...	145,920	90,696	236,616	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
FRONTIER PROVINCE.												
...	...	...	...	41,154	...	...	...	7,749	...	48,903	1900-01 to 1939-40.	
...	...	...	...	29,804	...	...	...	...	...	29,804	1905-06 to 1936-37.	
...	...	...	...	38,069	...	...	1,714	.	...	39,783	1905-06 to 1928-29.	
...	...	...	.	5,385	...	...	27,404	...	...	32,789	1906-07 to 1920-21.	
...	...	...	...	114,412	...	...	29,118	7,749	...	151,279		
JAB.												
...	...	...	...	...	...	...	45,617	...	47,394	93,011	1896-97 to 1925 26.	
..	...	...	47,595	...	...	...	...	7,709	60,450	115,754	1899-1900 to 1928-29.	
...	...	...	47,595	...	...	...	45,617	7,709	107,844	208,765		
...	...	..	...	145,140	...	...	408,495	213,487	19,775*	786,897	...	* Bamboo Circle.
...	...	...	...	145,140	...	...	408,495	213,487	...	786,897		
...	...	...	...	1,159,280	...	..	...	158,581	...	1,317,861	1897 98 to 1931-32.	
...	...	...	...	1,159,280	...	...	...	158,581	...	1,317,861		
...	...	...	...	95,491	...	...	...	10,241	40,188	145,920	1905-06 to 1934-35.	
...	...	...	..	95,491	...	...	...	10,241	40,188	145,920		

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
				AREA IN ACRES.						
		Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
										PUN
Punjab.	Punjab.	Simla	Reserved	20,338	...	20,338	Kalesar Reserved Forests.	Sal; etc.	2	...
			Unclassed	2,195	...	2,195	Simla Municipal Forests.	Deodar; Oak; Pinus longifolia; Rhododendron; etc.	4	...
							Simla Catchment Area Forests.	Deodar; Oak; Pinus excelsa; Picea Morinda.	3	...
							Kotkhai, Kotguru Reserved Forests.	...	2	...
		Total	...	22,533	...	22,533	...	...	...	...
		Lahore	Reserved	14,080	6,516	20,596	Changa Manga Plantation.	Dalbergia Sissoo; Morus indica.	1	...
			Protected	...	7,911	7,911				
			Unclassed	...	75,910	75,910	Shahdera-Cum-Jhugion Plantation.	...	1	...
		Total	...	14,080	90,337	104,417	...	...	...	...
		Multan	Reserved	72,320	13,213	85,533	South Kabirwala and Mailsi Forests.	...	2	..
			Protected	...	1,537,928	1,537,928				
			Unclassed	...	17,903	17,903				
		Total	...	72,320	1,569,044	1,641,364	...	...	...	...
		Jhelum	Reserved	..	191,070	191,070	...	...	...	...
			Unclassed	...	62,008	62,008	...	...	...	...
		Total	...	...	253,078	253,078	...	...	...	...
		Chenab	Reserved	...	67,883	67,883	...	...	...	...
			Unclassed	...	4,105	4,105	...	...	...	...
		Total	..	.	71,988	71,988	...	...	...	...
		Montgomery	Reserved	...	64,863	64,863	...	...	...	...
			Unclassed	...	391,669	391,669	...	...	...	...
		Total	...	...	456,532	456,532	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
JAB—*contd.*												
...	...	...	...	...	...	1,814	...	6,755	1,404	9,973	1898-99 to 1922-23.	
...	...	...	...	...	...	...	127	2,034	...	2,161	1897-98 to 1926-27.	
...	...	...	...	...	...	...	263	1,719	...	1,982	1896-97 to 1919-20.	
...	...	...	...	...	...	...	...	8,417	...	8,417	1901-02 to 1920-21.	
...	...	...	...	...	...	1,814	390	18,925	1,404	22,533		
...	...	...	...	...		...	10,332	...	960	11,292	1895-97 to 1910-11.	
...	...	...	...	...	...	...	1,828	...	960	2,788	1901-02 to 1915-16.	
...	...	...	...	...	...	...	12,160	...	1,920	14,080		
...	...	...	...	...	...	72,320	...	...	...	72,320	1897-98 to 1920-21.	
...	...	...	...	...	...	72,320	...	...	...	72,320		
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...		

Name of Province.	Name of Conservator's Circles.	FOREST DIVISION. Name of Forest Division.	Class of Forests.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
										PUN
Punjab.	Punjab.	Shahpur .	Reserved .	...	401,369	401,369	...	...	...	...
			Unclassed.	...	21,060	21,060	...	...	...	...
		Total .	...	...	422,429	422,429	...	...	...	...
		Pir Mahal .	Reserved .	...	14,659	14,659	...	...	4	...
			Protected.	...	9,240	9,240	...	...	1	...
			Unclassed.	...	19,883	19,883	...	...	1	...
		Total .	...	...	43,782	43,782	...	...	...	...
		GRAND TOTAL	...	2,568,376	3,280,524	5,848,900	...	...	...	...
										UNITED
United Provinces.	Western Circle.	Naini Tal .	Reserved .	79,855	27,677	107,532	Naini Tal Sub-Divisional Forests.	Pinus longifolia; Oak; Sal; etc.	12	..
							Naini Tal Municipal Forests.	Oak; Pinus longifolia; Pieris ovalifolia; Rhododendron arboreum; etc.	...	...
							Naini Tal Cantonment Forests.	...	...	...
			Protected .	16,757	...	16,757	Ranikhet Sub-Divisional Forests.	Pinus longifolia; Oak; Pieris ovalifolia; Rhododendron; etc.	17	...
							Ranikhet Cantonment Forests.	Pinus longifolia; Oak; etc.	...	...
							Muktesar Reserved Forests.	Oak; Pinus longifolia; etc.	1	...
		Total .	...	96,612	27,677	124,289	...	...	...	...
		Garhwal .	Reserved .	308,341	5,247	313,588	Garhwal Forest Division.	Sal; T. tomentosa; Anogeissus latifolia; etc.	6	2
							Rehar Garibul Chand Forests.	Sal; Terminalia tomentosa; etc.	2	...
		Total .	...	308,341	5,247	313,588	...	...	...	...
		Ganges . .	Reserved .	275,494	6,824	282,318	Ganges Forests Division.	Sal; Terminalia tomentosa; Dalbergia Sissoo; etc.	7	...
							Lansdowne Reserved Forests.	Sal; Pinus longifolia; etc.	2	...
		Total .	...	275,494	6,824	282,318	...	...	...	...

WORKING PLANS.

AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.

Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	REMARKS.
JAB—*concld.*												
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	..	...	...	...	...	...	...	...	
...	...	...	47,595	1,399,911	...	74,134	466,662	408,943	171,131	2,568,376	...	
PROVINCES.												
...	...	...	...	47,742	...	...	3,706	...	..	51,448	1896-97 to 1915-16	
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...		
...	...	17,392	...	25,737	...	...	...	...	...	43,129	1898-99 to 1917-18.	
...	...	...	...	...	...	...	..	...	...	...		
...	...	...	...	2,035	...	...	...	...	...	2,035	1900-01 to 1919-20.	
...	...	17,392	...	75,514	...	..	3,706	...	...	96,61		
...	...	...	...	40,914	...	...	...	148,682	78,223	267,819	1893-94 to 1914-15.	
...	...	...	...	...	...	...	...	40,522	...	40,522	1894-95 to 1913-14.	
...	...	...	...	40,914	...	...	...	181,204	78,223	308,341		
...	...	...	...	28,462	...	7,348	...	195,283	32,931	264,024	1893-94 to 1914-15.	
...	...	...	...	3,494	...	...	...	7,976	...	11,470	1904-05 to 1933-34.	
...	...	...	...	31,956	...	7,348	...	203,259	32,931	275,494		

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.		AREA IN ACRES.			DETAILS OF			
		Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
United Provinces—*contd.*	Western Circle—*contd.*									UNITED
		Sewalik . .	Reserved	365,926	...	365,926	Dehra Dun Forests	Sal; Dalbergia Sissoo; Acacia Catechu; etc.	8	16
			Unclassed	...	7,446	7,446	Berkala, Dholkhand and Ranipur Ranges.	Sal; Terminalia tomentosa; Cedrela Toona; etc.	4	4
		Total .	...	365,926	...	373,372	...	...	...	...
		Jaunsar . .	Reserved .	91,035	...	91,035	Jaunsar-Bawar Forests.	Deodar; Pinus longifolia; P. excelsa; Oaks; Picea Morinda; Sal, etc.	12	...
							Tehri-Garhwal leased Chir Forests.	Pinus longifolia; etc.	1	...
			Leased .	100,399	...	100,399	Tehri-Garhwal leased Deodar Forests.	Deodar, etc. . .	3	8
		Total .	...	191,434	...	191,434	.....	.....	...	...
		GRAND TOTAL .	...	1,237,807	47,194	1,285,001	.....	.....	...	...
	Eastern Circle.	Kumaun .	Reserved .	333,672	2,731	336,403	Kumaun Forest Division.	Sal, etc. . . .	10	2
		Total .	...	333,672	2,781	336,403			...	...
		Pilibhit . .	Reserved	133,302	...	133,302	Pilibhit Open Forests.	Sal, etc. . . .	2	7
							Pilibhit Closed Forests.	Sal, etc. . . .	2	4
							Surai-Banbasa Forests.	Sal, etc. . . .	3	...
		Total .	...	133,302	...	133,302			...	...
		Kheri . .	Reserved .	266,429	21,559	287,988	Bhira Range (Hirapur Working Circle).	Sal, etc. . . .	5	...
							Bhira Range Forests.	Sal, Terminalia tomentosa; etc.	3	...
							Trans-Sarda Forests.	Sal, etc. . . .	5	...
		Total .	...	266,429	21,559	287,988	.....	.....	...	...

WORKING PLANS.												
AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Stored Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked	Grand Total.	Period of each Working Plan.	REMARKS.
PROVINCES—*contd.*												
...	...	641	879	39,267	...	...	17,227	119,485	...	177,499	1903-04 to 1926-27.	
...	...	...	...	...	...	...	25,522	10,112	152,793	188,427	1908-09 to 1937-38.	
.	...	641	879	39,267	...	...	42,749	129,597	152,793	365,926		
...	...	33,626	...	55,705	...	...	9,240	...	...	98,571	1900-01 to 1939-40.	
...	...	33,000	...	...	...	...	...	...	10,100	43,100	1895-96 to 1925-26.	
...	...	3,307	...	31,624	...	...	...	..	14,832	49,763	...	
...	...	69,933	...	87,329	...	...	9240	...	24,932	191,434	1905-06 to 1944-45.	
..	...	87,966	879	274,980	...	7,348	55,695	522,060	288,879	1,237,807	...	
...	...	...	...	202,342	...	...	...	60,144	71,186	333,672	1892-93 to 1936-37.	
...	...	...	...	202,342	...	...	...	60,144	71,186	333,672	...	
...	...	...	...	...	...	...	50,420	...	...	50,420	1902-03 to 1933-34.	
...	...	..	...	...	...	...	14,971	16,048	14,104	45,123	1907-08 to 1933-34.	
...	...	...	...	1,610	...	...	...	11,400	24,749	37,759	1901-02 to 1910-11.	
...	...	...	...	1,610	...	...	65,391	27,448	38,853	133,302	...	
...	...	...	...	...	...	...	23,395	11,478	12,674	47,547	1896-97 to 1917-18.	
..	...	..	..	...	...	...	29,648	15,721	2,681	48,050	1894-95 to 1917-18.	
...	...	...	...	170,832	...	...	...	...	...	170,832	1903-04 to 1932-33.	
...	...	...	..	170,832	...	..	53,043	27,199	15,355	266,429	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
										UNITED
United Provinces.—*concld.*	Eastern Circle.	Bahraich .	Reserved .	213,944	...	213,944	Motipur Range Forests.	Sal, etc. . . .	5	...
							Chakia-Charda Forests.	Sal, etc. . . .	4	...
							Bhinga Range Forests	Sal, etc. . .	5	...
		Total . .	...	213,944	...	213,944	...	...	...	...
		Gonda . .	Reserved .	103,785	...	103,785	Tikri Forests .	Sal, etc. . . .	1	...
							Tulsipur Forests .	Sal, etc. . . .	5	...
		Total . .	...	103,785	...	103,785	...	...	...	...
		Gorahkpur . .	Reserved .	110,721	...	110,721	Gorakhpur Forests .	...	7	...
		Total .	...	110,721	...	110,721	...	...	...	...
		Bundelkhand	Reserved .	...	171,687	171,687	...	...	...	...
			Protected .	...	2,729	2,729	...	...	...	...
			Unclassed .	...	18,928	18,928	...	...	...	...
		Total .	...	...	193,344	193,344	...	...	...	...
		GRAND TOTAL	...	1,181,853	217,634	1,379,487	...	...	...	...
		GRAND TOTAL	...	2,399,660	264,828	2,664,488	...	...	...	...
										BEN
Bengal.	Bengal.	Darjeeling . .	Reserved .	24,736	50,283	75,019	Darjeeling Forests	Oak, Chestnut, Michelia Champaca, etc.	4	7
		Total .	...	24,736	50,283	75,019	...	...	...	...
		Tista . .	Reserved .	141,611	...	141,611	Tista Division Forests.	Sal; Cedrela Toona; Walnut; Bucklondia populnea; Oak; etc.	6	10
		Total . .	...	141,611	...	141,611	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Stored Method.	Simple Coppice Method	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
PROVINCES—*concld.*												
...	...	...	...	...	...	...	...	42,163	78,220	120,383	1893-04 to 1907-08.	
...	...	...	...	...	...	...	4,245	11,863	7,652	23,760	1895-96 to 1914-15.	
...	...	...	...	...	...	...	...	23,108	46,693	69,801	1893-94 to 1907-08.	
...	...	...	...	...	...	...	4,245	77,134	132,565	213,944	...	
...	...	...	...	...	...	...	13,456	...	...	13,456	...	
...	...	...	...	44,286	...	...	...	...	46,043	90,329	1900-01 to 1919-20.	
...	...	...	...	44,286	...	...	13,456	...	46,043	103,785	...	
...	...	...	...	...	...	...	25,995	40,470	44,256	110,721	1893-94 to 1912-13.	
...	...	...	...	...	...	...	25,995	40,470	44,256	110,721	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	419,070	...	...	162,130	232,395	348,258	1,161,853	...	
..	...	87,966	879	694,050	...	7,348	217,825	754,455	637,137	2,399,660	...	
GAL.												
...	...	24,736	...	...	...	...	...	...	...	24,736	1902-03 to 1911-12.	
...	...	24,736	...	...	...	...	...	...	...	24,736	...	
...	...	...	...	129,356	...	...	12,255	...	...	141,611	1906-07 to 1920-21.	
...	...	...	...	129,356	...	...	12,255	...	...	141,611	...	

Name of Province. Bengal—*contd.*
Name of Conservator's Circle. Bengal—*contd.*

FOREST DIVISION.					DETAILS OF			
Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
								BEN
Kurseong .	Reserved .	68,082	...	68,082	Kurseong Reserved Forests.	Sal, etc. . . .	2	3
Total .	...	68,082	...	68,082	...	...	...	...
Palamau . {	Reserved .	...	156,769	156,769	...	...	...	...
	Protected .	..	20,780	20,780				
Total .	...	...	177,549	177,549	...	...	...	...
Singhbhum . {	Reserved .	463,847	1,098	464,945	Singhbhum Reserved Forests.	Sal, etc. . .	6	6
	Protected	...	112,856	112,856				
Total .	...	463,847	113,954	577,801	...	.. ...	...	...
Sambalpur .	Reserved .	44,606	208,553	253,159	Barapahar Range Forests.	.....	2	9
Total .	...	44,606	208,553	253,159	...	.. ...	...	...
Angul . .	Reserved .	..	146,801	146,801	Angul Forests .	Sal, etc. . .	4	4
Total .	...	...	146,801	146,801	...	.....	...	...
Puri . . {	Reserved .	72,489	...	72,489	Puri Reserved Forests.	Sal, etc. . .	3	16
	Protected.	...	231,218	231,218				
Total .	...	72,489	231,218	303,707	...	.....	...	...
Sundarbans . {	Reserved .	1,331,712	...	1,331,712	Sundarbans Division Forests.	Heritiera minor, etc.	4	4
	Protected	1,109,310	...	1,109,310				
Total .	...	2,441,022	...	2,441,022	..	.....	...	...
Sonthal Parganas.	Protected	...	186,827	186,827	...	.....	...	...
Total .	...	...	186,827	186,827	...	... ..	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Shoreyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked	Grand Total.		
GAL—*contd.*												
...	...	...	...	68,082	...	...	...	...	...	68,082	1904-05 to 1918-19.	
...	...	...	...	68,082	...	...	...	...	...	68,082	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	442,649	...	...	21,198	...	...	463,847	1903-04 to 1915-16.	
...	...	...	...	442,649	...	...	21,198	...	...	463,847	...	
...	...	...	...	...	..	...	6,549	38,057	...	44,606	1895-96 to 1924-25.	
...	...	...	...	...	...	...	6,549	38,057	...	44,606	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	37,439	...	...	35,050	...	...	72,489	1905-06 to 1919-20.	
...	...	...	...	37,439	...	...	35,050	...	...	72,489	...	
...	...	...	...	...	...	...	..	750,080	1,690,942	2,441,022	1906-07 to 1909-10.	
...	...	...	...	...	..	...	...	750,080	1,690,942	2,441,022	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circle.	Number of Felling Series.
Bengal—*concld.*	Bengal—*concld.*									BENGAL
		Chaibassa .	Protected	...	126,801	126,801	...	.....	...	...
		Total .	...	...	126,801	126,801	...	.....	...	...
		GRAND TOTAL	...	3,256,393	1,241,986	4,498,379	...	.....	...	...
										EASTERN BENGAL
Eastern Bengal and Assam.	Eastern Bengal and Assam.	Chittagong .	Reserved .	...	1,262,278	1,262,273	.....	.....	...	...
			Other reserves.	...	3,008	3,008				
			Unclassed .	...	2,390,700	2,390,700				
		Total .	...	...	3,655,981	3,655,981	.....	.....	...	...
		Jalpaiguri .	Reserved .	113,586	...	113,586	Reserved Forests of the Jalpaiguri Division.	Sal, etc. . . .	5	19
			Other reserves.	...	502	502				
			Protected .	...	2,507	2,507				
		Total .	...	113,586	3,009	116,595	.....	.....	...	...
		Buxa . .	Reserved .	208,865	...	208,865	Buxa Forest Division.	.....	5	6
			Unclassed .	...	315	315				
		Total .	...	208,865	315	209,180	.....	.....	...	...
		Cachar .	Reserved .	...	393,203	393,203	.....	.....	...	...
			Unclassed .	...	1,219,021	1,219,021				
		Total .	...	...	1,612,224	1,612,224	.....	.....	...	...
		Sylhet .	Reserved .	...	65,920	65,920	.....	.....	...	...
			Unclassed .	...	99,964	99,964				
		Total .	...	...	165,884	165,884	.....	.....	...	...
		Khasi and Jaintia Hills.	Reserved .	...	32,967	32,967	.....	.....	...	...
			Unclassed	...	63,745	63,745				
		Total .	...	...	96,722	96,722	.....	.....	...	...
		Lushai Hills .	Reserved .	...	133,760	133,760	.....	.....	...	...
		Total .	...	...	133,760	133,760	.....	.....	...	...

WORKING PLANS.

Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	REMARKS.
AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.												
—concld.												
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	24,736	...	677,526	...	...	75,052	788,137	1,690,942	3,256,393	...	
AND ASSAM.												
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	64,380	49,206	...	113,586	1904-05 to 1923-24.	
...	...	...	...	...	...	...	64,380	49,206	...	113,586	...	
...	...	...	...	208,865	...	...	...	...	...	208,865	1905-06 to 1919-20.	
...	...	...	...	208,865	...	...	...	...	..	208,865	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	

Name of Province. / Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
	Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
Eastern Bengal and Assam—*concld.* / Eastern Bengal and Assam—*concld.*								EASTERN BENGAL	
	Goalpara	Reserved	334,402	169,190	503,592	Goalpara Sal Forests.	Sal	5	...
		Unclassed	..	217,373	217,373				
	Total	...	334,402	386,563	720,965	.....	.....	...	...
	Kamrup	Reserved	...	167,238	167,238	.....	.....	...	...
		Unclassed.	...	1,367,079	1,367,079				
	Total	...	...	1,534,317	1,534,317	.....	.....	...	...
	Darrang ...	Reserved	1,988	212,786	214,774	Sal Forests of the Darrang Division.	Sal	1	...
		Unclassed	...	1,305,070	1,305,070				
	Total	...	1,988	1,517,856	1,519,844	.....	.....	...	...
	Nowgong	Reserved	...	126,873	126,873	.....	.....	..	...
		Unclassed.	...	2,156,883	2,156,883				
	Total	...	...	2,283,756	2,283,756	.....	.....	...	...
	Sibsagar	Reserved	41,133	616,544	657,677	Number Reserved Forests.	.....	1	...
		Unclassed.	...	1,894,966	1,894,966				
	Total	...	41,133	2,511,510	2,552,643	.....	.....	...	...
	Lakhimpur	Reserved	...	221,392	221,392	.....	.....	...	...
		Unclassed.	...	1,911,586	1,911,586				
	Total	...	...	2,132,978	2,132,978	.....	.....	...	...
	Garo Hills	Reserved	6,812	83,084	89,896	Dambu Reserve	.....	1	...
		Unclassed.	...	1,884,924	1,884,924	Darugiri Reserve	.....	1	...
	Total	...	6,812	1,968,008	1,974,820	.....	.....	...	...
	GRAND TOTAL	...	706,786	18,002,873	18,709,659	.....	.....	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.			
AND ASSAM—*concld.*													
...	...	...	...	334,402	...	...	...	...	...	334,402	...		Plan under revision
...	...	...	...	334,402	...	...	...	...	...	334,402	...		
...	...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	1,988	...	1,988	1906-07 to 1911-16.		
...	...	...	...	...	...	...	...	1,988	...	1,988	..		
...	...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	..	...	...		
...	...	...	...	41,133	...	...	...	...	...	41,133	1904-05 to 1911-12.		
...	...	...	...	41,133	...	...	...	...	...	41,133	...		
...	...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	4,364	...	...	...	...	...	4,364	1-4-1887 to 31-3-1902.		
...	...	...	...	2,448	...	...	...	...	...	2,448	1-4-1890 to 31-3-1905.		
...	...	...	...	6,812	...	...	...	...	...	6,812	...		
...	...	...	...	591,212	...	...	64,380	51,194	...	706,786	...		

Name of Province. Eastern Bengal and Assam—contd.
Name of Conservator's Circle. Central Provinces.
Northern Circle.

FOREST DIVISION.						DETAILS OF		
Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
							CENTRAL	
Mandla	A class	62,512	1,035,462	1,097,914	Bonjar Valley Forests.	.....	1	...
	B class	...	546,075	546,075	Motinala Range Forests.	.....	2	...
Total	...	62,512	1,581,477	1,643,989	.....	.....	...	...
Jubbulpore	A class	332,496	...	332,496	Jubbulpore Forest Division.	.....	5	44
Total	...	332,496	...	332,496	.....	.....	...	...
Damoh	A class	506,832	...	506,832	Damoh Forest Division.	.....	4	...
Total	...	506,832	...	506,832	.....	.....	...	...
Sangor	A class	14,080	462,949	477,029	Sangor Forest Division.	.....	6	27
	B class	...	6,302	6,302				
Total	...	14,080	469,251	483,331	.....	.....	...	...
Narsinghpur	A class	159,392	...	159,392	Narsinghpur Forest Division.	.....	3	12
Total	...	159,392	...	159,392	.....	.....	...	...
Hoshangabad	A class	473,600	127,596	601,196	Hoshangabad Forest Division.	.....	4	26
					Bori Range Forests	.....	1	3
Total	...	473,600	127,596	601,196	...	.....	...	...
Seoni	A class	521,200	...	521,200	Korai Range Forests.	.....	7	...
					Gangimala Range Forests.	.....	6	...
	B class	...	6,811	6,811	Ugli Range Forests.	.....	7	...
	Unclassed	...	1,791	1,791	Chappara, Dhooma and Nerbudda Ranges.	.....	9	17
Total	...	521,200	8,602	529,802	.....	.....	...	...

WORKING PLANS.

AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.

Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Stored Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	REMARKS.
PROVINCES.												
...	...	...	...	15,971	...	...	..	...	46,541	62,512	1904 to 1935.	
...	...	...	...	...	...	...	...	...	...	...	1907-08 to 1937-38.	
...	...	...	...	15,971	...	...	...	...	46,541	62,512	...	
...	...	...	...	...	...	...	...	260,202	72,290	332,492	1899-1900 to 1928-29.	
...	...	...	...	...	...	...	...	260,202	72,290	332,492	...	
...	...	...	...	...	...	.	506,719	...	113	506,832	1899-1900 to 1928-29.	
...	...	...	...	...	...	...	506,719	...	113	506,832	...	
...	...	...	...	...	..	...	...	...	14,080	14,080	1903-04 to 1932-33.	
...	...	...	...	...	...	...	...	...	14,080	14,080	...	
..	...	...	...	...	...	...	23,884	...	135,508	159,392	1897 to 1917.	
...	...	...	...	...	...	...	23,884	...	135,508	159,392	...	
...	...	...	...	...	...	...	...	240,948	232,652	473,600	1897-98 to 1926-27.	
...	...	...	...	...	...	...	...	...	..	...	1897-98 to 1906-07.	
...	...	...	...	...	...	...	...	240,948	232,652	473,600	...	
...	...	...	...	...	...	...	...	100,740	20,616	121,356	1895-96 to 1924-25.	
21,523	...	...	...	...	...	...	6,116	31,006	42,836	81,481	1895-96 to 1924-25.	
...	...	...	...	...	...	...	...	33,105	52,288	85,393	1898-99 to 1927-28.	
...	...	...	..	...	...	...	...	144,054	88,916	232,970	1900-01 to 1929-30.	
21,523	...	...	...	...	...	...	6,116	308,905	184,656	521,200	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
										CENTRAL
Central Provinces.	Central Provinces—*contd.* Northern Circle—*contd.*	Chhindwara	A class B class	426,798 ...	... 33,042	426,798 33,042	Siliwani Ghat Range Forests. Sauk Range Forests Umreth Range Forests. Amarwara Range Forests. Ambara Range Forests.	....	6 5 3 4 4	 4
		Total	...	426,798	33,042	459,840	... ...	... ...	...	...
		GRAND TOTAL	...	2,496,906	2,219,968	4,716,874	.....	.....	...	...
	Central Provinces—*contd.* Southern Circle.	Balaghat	A class	554,240	72,738	626,978	Dhansua Range Forests. Sonawani Range Forests. Pandratola Reserve Forests. Baihar and Raigarh Range Forests. Paraswara Range Forests.	... ...	9 7 1 1 8	... ... 2 ...
		Total	...	554,240	72,738	626,978	...	...	...	...
		Bhandara	A class B class	335,568 ...	... 5,497	335,568 5,497	Paoni Range Forests Bawan Thari Range Forests. Lakhni Range Forests. Gaikhuri Range Forests. Pertabgarh Range Forests.	... ...	4 7 3 8 6	... ...
		Total	...	335,568	5,497	341,065	...	...	...	...
		Bilaspur	A class	260,480	165,005	425,485	Chita Pandaria Range Forests. Lormi Range Forests.	... ...	1 3	... ...
		Total	...	260,480	165,005	425,485	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
PROVINCES—*contd.*												
...	...	...	...	...	...	...	...	35,738	37,313	73,051	1895-96 to 1924-25.	
...	...	...	...	...	...	...	...	46,992	18,519	65,511	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	8,028	95,896	103,924	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	16,741	49,053	65,794	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	32,832	85,686	118,518	1901-02 to 1920-21.	
...	...	...	...	...	...	...	...	140,331	286,467	426,798	...	
21,523	...	...	...	15,971	...	...	536,719	950,386	972,307	2,496,906	...	
...	...	...	...	...	...	...	...	57,264	112,208	169,472	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	38,333	32,347	70,682	1896-97 to 1920-21.	
...	...	...	...	...	...	...	...	11,046	1,145	12,191	1896-97 to 1910-11.	
...	...	...	...	...	...	...	...	58,228	141,071	199,299	1906-07 to 1925-26.	
...	...	...	...	...	...	...	...	16,067	86,531	102,598	1899-1900 to 1928-29.	
...	...	...	...	...	...	...	...	180,938	373,302	554,240		
...	...	...	...	...	...	...	...	24,094	1,496	25,590	1893-94 to 1923-24.	
...	...	...	...	...	...	...	...	29,398	63,387	92,785	1893-94 to 1922-23.	
...	...	...	...	...	...	...	...	38,839	840	39,679	Do.	
...	...	...	...	...	...	...	...	40,488	52,615	93,103	1896-97 to 1925-26.	
...	...	...	...	...	...	...	25,240	...	59,171	84,411	1897-98 to 1926-27.	
...	...	...	...	...	...	...	25,240	132,819	177,509	335,568	...	
...	...	...	...	...	...	...	2,136	...	...	2,136	1895-96 to 1915-16.	
...	...	...	...	...	...	...	...	20,098	238,246	258,344	1898-99 to 1927-28.	
...	...	...	...	...	...	...	2,136	20,098	238,246	260,480	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
										CENTRAL
Central Provinces—*contd.*	Southern Circle.—*contd.*	South Chanda	A class B I class B II class	262,400	225,223 219,288 332,100	487,623 219,288 332,100	Ahiri Range Forests Ghote Range	... ...	2 1	... 11
		Total	...	262,400	776,611	1,039,011	...	...	...	...
		North Chanda	Reserved B I class	837,995 ...	... 270,455	837,995 270,455	Salori and Ainsa Forests. Warora Range Forests. Moharli Range Forests. Haveli Range Forests. Gungewahi Range Forests. Brahmapuri Range Forests. Wairagarh and Dhaba Range Forests.	... ...	2 5 11 11 13 11 2	... ...
		Total	...	837,995	270,455	1,108,450	...	...	...	...
		Nagpur Wardha.	A class	458,059	...	458,059	Arvi Range Forests Khondali Range Forests. East Pench Range Forests. West Pench Range Forests. Umrer Range Forests.	... ...	7 6 6 7 5	... ...
		Total	...	458,059	...	458,059	...	...	...	...
		Raipur	A class	873,461	6,400	879,861	Billari Ghugwa Range Forests. Sirpur Khallari Range Forests. Dhantari Range Forests. Laun Range Forests Balod Range Forests. Sihawa Range Forests.	... ...	2 6 5 3 5 4	 3
		Total	...	873,461	6,400	879,861	...	...	...	...
		GRAND TOTAL	...	3,582,203	1,296,706	4,878,909	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan	Remarks.
PROVINCES - *contd.*												
...	...	..	...	19,575	...	...	..	...	25,307	44,882	1896-97 to 1934-35	
...	...	..	...	...	...	...		45,244	172,274	217,518	1899-1900 to 1913-14.	
...	..	...	...	19,575	...	...	...	45,244	197,581	262,400	...	
...	...	...	..	.	..	...	12,559	...	...	12,559	1895 to 1924	
...	...	...	..	...	...	..	...	32,661	28,284	60,945	1898-99 to 1927-28.	
...	...	...	...	...	...	...	...	32,312	215,922	248,234	1896-97 to 1925-26.	
..	.	...	...	...	...	..	...	23,348	100,503	123,851	1897-98 to 1911-12.	
...	...	.	...	...	...	..	..	54,171	76,296	130,467	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	47,146	44,486	91,632	1895-96 to 1924-25.	
...	...	...	..	.	..	...	...	..	170,307	170,307	...	
..	...	..	...	..	...	...	12,559	189,638	635,798	837,995		
...	...	...	..	...	...	...	..	48,138	69,160	117,298	1895-96 to 1924-25.	
...	...	...	...	...	...	..	. .	42,541	20,881	63,422	Do.	
...	...	...	..	...	...	...	...	69,914	73,583	143,497	1894-95 to 1932-33.	
...	...	...	...	...	...	..	..	37,484	37,850	75,334	1894-95 to 1923-24.	
...	...	...	. .	..	...	...	...	41,700	16,808	58,508	Do.	
...	...	...	...	...	...	...	...	239,777	218,282	458,059		
...	...	...	...	..	..	..	1,200	...	406	1,606	1894-95 to 1913-14.	
...	...	...	...	...	.	...	...	25,412	75,229	1.0,641	1896-97 to 1925-26.	
...	...	...	..	...	...	...	55,178	...	57,795	112,973	1893-94 to 1922-23.	
...	...	...	...	...	...	...	16,420	.	141,255	151,675	1898-99 to 1927-28.	
...	...	...	...	...	...	...	45,767		51,120	96,887	1893-94 to 1922-23.	
...	...	...	...	...	...	...	12,809	56,014	340,856	409,679	1900 to 1930.	
...	...	...	...	..	...	..	125,374	81,426	666,661	873,461	...	
...	...	...	...	19,575	...	...	165,309	889,940	2,567,379	3,582,203	...	

Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
			AREA IN ACRES.						
	Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
									CENTRAL
Berar Circle.	Melghat .	...	449,540	89,809	962,821	Bairagarh-Gugumal Forests.	...	5	...
	Total .	...	449,540	89,809	962,821	...	...	...	...
	Amraoti . .	...	...	161,741	161,743	...	...	...	...
	Total .	...	...	161,741	161,743	...	...	..	...
	Buldana and Akola.	...	2,994	501,776	504,770	Loni-Bhongaon Forests.	...	2	...
	Total .	...	2,994	501,776	504,770	...	. .	...	...
	Yeotmal . .	...	12,027	751,262	763,289	Penganga Reserve.	...	1	...
	Total .	...	12,027	751,262	763,289	...	...	...	...
	Betul .	...	755,684	90,672	846,356	Betul Forest Division.	...	7	24
	Total .	...	755,684	90,672	846,356	...	...	...	...
	Nimar . .	...	180,524	1,066,315	1,246,835	Kalibhit Working Circle.	...	1	4
	Total .	...	180,524	1,066,315	1,246,839	...	...	...	...
	GRAND TOTAL.	...	1,400,769	3,085,049	4,485,818	...	...	...	...
	GRAND TOTAL	...	7,479,878	6,601,723	14,081,601	...	...	..	...
									COO
Coorg.	Coorg .	Reserved .	113,727	219,199	332,926	Devamachi-Mawkal Forests.	...	1	...
						Arkeri Reserved Forests.	...	1	...
						Anekadu-Attur Forests.	...	1	...
						Dubare Reserved Forests.	...	1	...
						Nalkeri-Hatgat Forests.	...	4	...
	Total .	...	113,727	219,199	332,926	...	...	...	...
	GRAND TOTAL.	...	113,727	219,199	332,926	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings	Area under Unregulated Fellings or Unworked	Grand Total.	Period of each Working Plan.	Remarks.
PROVINCES—*concld.*												
...	...	...	...	...	...	...	...	297,576	151,964	449,540	1893-94 to 1907-08.	
...	...	...	...	...	...	...	...	297,576	151,964	449,540	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	..	...	
2,994	...	...	...	...	...	...	...	...	...	2,994	1895-96 to 1909-10.	
2,994	...	...	...	...	...	...	...	...	...	2,994	...	
...	...	...	...	...	...	...	...	12,027	...	12,027	1893-94 to 1910-11.	
...	...	...	...	...	...	...	...	12,027	...	12,027	...	
...	...	...	...	...	...	...	...	407,024	348,660	755,684	1897-98 to 1926-27.	
...	..	...	...	...	...	...	...	407,024	348,660	755,684	...	
...	...	...	...	...	...	...	...	83,148	97,376	180,524	1897-98 to 1926-27.	
...	...	...	...	...	...	...	...	83,148	97,376	180,524	...	
2,994	...	...	...	...	...	...	...	799,775	598,000	1,400,769	...	
24,517	...	...	...	35,546	...	...	702,028	2,640,101	4,077,686	7,479,878	...	
RG.												
...	...	...	...	...	...	...	...	12,287	5,387	17,674	1899-1900 to 1909-10.	
...	...	...	...	...	...	...	...	18,262	...	18,262	1897-98 to 1911-12.	
...	...	...	...	12,877	...	...	...	...	...	12,877	1894-95 to 1903-09.	
...	...	...	...	...	...	..	...	11,363	...	11,363	1899-1900 to 1913-14.	
...	...	...	...	30,774	...	...	...	...	22,777	53,551	1886 to 1915.	
...	...	...	...	43,651	...	...	...	41,912	28,164	113,727	...	
...	...	...	...	43,651	...	...	...	41,912	28,164	113,727	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series
Ajmer-Merwara.	Ajmer-Merwara.									AJMER
		Ajmer	Reserved	89,670	1,009	90,678	Ajmer-Merwara Forests.	...	4	...
			Protected	110	5	115				
			Unclassed	...	3,471	3,471				
		Total	...	89,780	4,485	94,265	...	...	...	...
		GRAND TOTAL	...	89,780	4,485	94,265	...	...	...	...
Burma (Lower).	Pegu Circle.									BUR
		Theyetmyo	Reserved	84,204	285,276	369,480	East Yoma, Satsuwa and Tinduw Reserves.	...	1	...
			Unclassed	1,142	1,845,221	1,846,363				
		Total	...	85,346	2,130,497	2,215,843	...	...	...	..
		Prome	Reserved	208,080	401,771	609,851	Shwelo Forests	...	1	...
			Unclassed	...	908,082	908,082	Nawin Forests	...	3	...
		Total	...	208,080	1,309,853	1,517,933	...	...	...	...
		Zigon	Reserved	256,878	23,680	280,558	Kangyi Forests	...	1	...
							Gamon Forests	...	1	...
			Unclassed	...	244,051	244,051	Bawbin-Minbu Forests.	...	1	...
							Taunguyo Forests.	...	1	...
		Total	...	256,878	267,731	524,609	...	...	...	...
		Tharrawaddy	Reserved	200,326	25,808	226,134	Thonze Reserve	...	1	...
							Kadin Bilin Reserve	...	1	...
			Unclassed	...	110,146	110,146	Kon „ „	...	1	...
							Mokka „ „	...	1	...
							Minbla Reserve	.....	1	...
							Satpok, Sifkwin and Thindawyo Reserves.		3	...
		Total ...	...	200,326	135,954	336,280	.....	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
MERWARA.												
...	...	...	...	...	...	...	41,101	...	48,679	89,780	1896-97 to 1915-16.	
...	...	...	...	...	...	...	41,101	...	48,679	89,780	...	
...	...	...	...	...	...	...	41,101	...	48,679	89,780	...	
MA.												
...	...	...	...	85,346	...	...	...	...	...	85,346	1906-07 to 1937-38.	
...	...	...	...	85,346	...	...	...	...	...	85,346	...	
...	...	...	...	73,489	...	...	...	...	...	73,489	1892-93 to 1921-22.	
...	...	...	...	134,591	...	...	...	...	...	134,591	1893-94 to 1922-23.	
...			...	208,080	...	...	...	...	...	208,080	...	
...	...	...	...	4,896	...	...	...	...	...	4,896	1892-93 to 1921-22.	
...	...	...	...	61,773	...	...	...	...	...	61,773	1889-90 to 1923-24.	
...	...	...	...	83,331	...	...	...	...	...	83,331	1890-91 to 1919-20.	
...	...	...	...	106,878	...	...	...	...	...	106,878	1891-92 to 1920-21.	
...	...	...	...	256,878	...	...	...	...	...	256,878	...	
...	...	...	...	69,735	...	...	...	...	...	69,735	1885 to 1914	
...	...	...	...	51,192	...	...	...	...	...	51,192·2	1885-86 to 1914-15.	
...	...	...	...	15,988	...	...	...	...	...	15,988	1885-86 to 1914-15.	
...	...	...	...	24,668	...	...	...	...	...	24,668·2	1885-86 to 1914-15.	
...	...	...	...	25,453	...	...	...	...	...	25,453	1889 to 1923	
...	...	...	...	13,290	...	...	...	...	...	13,290	1904-05 to 1928	
...	...	...	...	200,326	...	...	...	...	...	200,326	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
				AREA IN ACRES.						
		Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
										BURMA—
Burma (Lower)—*contd.*	Pegu Circle—*contd.*	Rangoon	Reserved	173,584	71,961	245,545	Rangoon Plains Forests.	.....	1	...
			Unclassed	...	156,626	156,626	Rangoon Hill Forests.	.....	1	...
		Total	...	173,584	228,587	402,171	.....	.....	...	...
		Pegu	Reserved	146,271	634,078	780,349	South Zamayi Reserve.	.....	1	...
			Unclassed	...	161,091	161,091	.....	.....	...	...
		Total	...	146,271	795,169	941,440	.....	.....	...	...
		Bassein	Reserved	...	932,271	932,271	.....	.....	...	...
			Unclassed	...	1,927,680	1,927,680	.....	.....	...	...
		Total	...	...	2,859,951	2,859,951	.....	.....	...	...
		Henzada	Reserved	...	580,846	580,846	.....	.....	...	...
			Unclassed	...	154,560	154,560	.....	.....	...	...
		Total	...	...	735,406	735,406	.....	.....	...	...
		Arakan	Reserved	...	...	...	.....	.....	...	...
			Unclassed	...	10,788,842	10,788,842	.....	.....	...	...
		Total	...	...	10,788,842	10,788,842	.....	.....	...	...
		GRAND TOTAL	...	1,070,485	19,251,990	20,322,475	.....	.....	...	...
	Tenasserim Circle.	Taungoo	Reserved	759,720	148,321	908,041	Kabaung Reserve	.....	1	...
							Bondaung Reserve.	.....	1	...
							West Swa, Sabyin and Lonyan Reserve.	.....	1	...
							Kyaukmasin Reserve.	.....	1	...
			Unclassed	...	1,715,252	1,715,252	Gwethe Reserve	.....	1	...
							Saing Working Circle.	.....	1	...
							Pyu Chaung and Pyu Kun Reserves.	.....	1	...
		Total	...	759,720	1,863,573	2,623,293	.....	.....	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartment with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
contd.												
...	...	...	...	53,014	...	...	...	...	..	53,014	1905 to 1924	
...	...	...	...	120,570	...	...	...	...	...	120,570	1905 to 1935	
...	...	...	...	173,584	.	...	...	...	...	173,584	...	
...	...	...	...	146,271	...	...	...	...	..	146,271	1905 to 1935	
...	...	...	...	...	...	...	...	...	...	...	...	
...	..	...	...	146,271	...	...	...	...	...	146,271	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	..	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	..	...	..	...	
...	...	...	...	...	...	...	...	...	...	..	...	
...	...	..	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	..	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	. ...	...	...	...	...	...	...	
...	...	...	...	1,070,485	...	...	...	...	...	1,070,485	...	
...	...	...	...	188,934	...	...	...	...	...	188,934	1894-95 to 1923-24.	
..	...	...	...	23,757	...	...	...	...	...	23,757	Do.	
...	...	...	...	94,694	...	...	...		...	94,694	1897-98 to 1928-29.	
...	...	...	...	25,432	...	...	...	...	...	25,432	1898-99 to 1925-26.	
...	...	...	...	30,872	.	...	...	...	...	30,872	1899-1900 to 1928-29.	
...	...	...	...	108,384	...	...	...	...	...	108,384	Do.	
...	...	...	...	287,647	...	...	...	...	...	287,647	1892-93 to 1934-35	
...	...	...	...	759,720	...	...	...	...	...	759,720	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	DETAILS OF Number of Working Circles.	Number of Felling Series.
										BURMA
Burma (Lower)—*concld.*	Tenasserim Circle—*concld.*	Shwegyin	Reserved	384,167	79,831	463,998	Tonkan Reserve	.....	1	...
			Unclassed.	...	1,866,100	1,866,100	Nyaunglebin Working Circle.	.....	1	...
		Total	...	384,167	1,945,931	2,330,098	.....	.....	...	...
		West Salween	Reserved	...	227,887	227,887	.....	.....	...	...
			Unclassed.	...	2,235,607	2,235,607	.....	.....	...	...
		Total	...	...	2,463,494	2,463,494	.....	.....	...	...
		Thaungyin	Reserved	...	348,714	348,714	.....	.....	...	...
			Unclassed.	...	2,235,120	2,235,120	.....	.....	...	...
		Total	...	...	2,573,834	2,573,834	.....	.....	...	...
		Ataran	Reserved	...	476,142	476,142	.....	.....	...	...
			Unclassed.	...	2,724,264	2,724,264	.....	.....	...	...
		Total	...	...	3,200,406	3,200,406	.....	.....	...	...
		South Tenasserim	Reserved	...	831,450	831,450	.....	.....	...	...
			Unclassed.	...	6,138,438	6,138,438	.....	.....	...	...
		Total	...	...	6,969,888	6,969,888	.....	.....	...	...
		GRAND TOTAL	...	1,143,887	19,117,126	20,261,013	.....	.....	...	...
Burma (Upper.)	Northern Circle.	Upper Chindwin.	Reserved	...	958,096	958,096	.....	.....	...	...
			Unclassed.	...	4,731,760	4,731,760	.....	.....	...	...
		Total	...	...	5,689,856	5,689,856	.....	.....	...	...
		Myittha	Reserved	...	478,064	478,064	.....	.....	...	...
			Unclassed.	...	616,080	616,080	.....	.....	...	...
		Total	...	...	1,094,144	1,094,144	.....	.....	...	...
		Lower Chindwin.	Reserved	...	497,958	497,958	.....	.....	...	...
			Unclassed.	...	417,920	417,920	.....	.....	...	...
		Total	...	...	915,878	915,878	.....	.....	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	
—*contd.*												
...	...	...	...	...	...	...	...	14,041	5,620	19,661	1906-07 to 1913-14.	
...	...	...	...	363,618	...	...	...	..	888	364,506	1906-07 to 1934-35.	
...	...	...	...	363,618	...	..	...	14,041	6,508	384,167	...	
...	...	...	...	..	..	...	.	...				
...	...	...	...	..	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	.	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	..	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	..	...	..	...	...	...	...	...	
...	...	...	...	1,123,338	...	...	...	14,041	6,508	1,143,887	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	..	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
										BURMA
Burma (Upper)—*contd.*	Northern Circle—*contd.*	Mu . .	Reserved .	...	738,302	738,302	...	...	...	...
			Unclassed .	...	1,475,520	1,475,520	...	...	...	...
		Total .	...	...	2,213,822	2,213,822	..	...	...	...
		Katha . .	Reserved .	24,320	351,386	375,706	Mohnyin Reserve .	...	1	...
			Unclassed .	...	1,401,138	1,401,138				
		Total .	...	24,320	1,752,524	1,776,844	...	...	...	...
		Bhamo . .	Reserved .	...	215,619	215,619	..	...	...	..
			Unclassed .	...	2,555,520	2,555,520	...	...	...	...
		Total .	...	...	2,771,139	2,771,139	...	...	...	...
		Myitkyina . .	Reserved .	...	108,800	108,800	...	...	...	...
			Unclassed .	...	3,814,400	3,814,400	...	...	...	...
		Total .	...	...	3,923,200	3,923,200	...	...	...	...
		GRAND TOTAL	...	24,320	18,360,563	18,384,883	...	...	...	...
	Southern Circle.	Ruby Mines .	Reserved .	158,938	671,462	830,400	Nanhan, Nanpaw and Subok Reserves.	...	1	...
			Unclassed .	...	2,625,674	2,625,674	...	...	...	...
		Total .	...	158,938	3,297,136	3,456,074	...	...	...	...
		Mandalay . .	Reserved .	269,616	724,329	993,945	Madaya Range .	...	1	...
			Unclassed .	...	5,936,546	5,936,546	Maymyo Fuel Reserve.	..	1	...
		Total .	...	269,616	6,660,875	6,930,491	...	...	...	...
		Yaw . .	Reserved .	...	561,065	561,065	...	...	...	...
			Unclassed	...	1,889,871	1,889,871	...	...	...	...
		Total .	...	...	2,450,936	2,450,936	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked	Grand Total.		
—*contd.*												
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	..	...	...	..	...	...	...	...	...	
..	...	...	...	24,320	...	...	...	...	...	24,320	1895-96 to 1909-10.	
...	..	...	...	24,320	...	...	...	...	...	24,320		
...	...	...	...	..	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	24,320	...	...	...	...	...	24,320	...	
...	...	...	...	158,938	...	...		...	...	158,938	1905 to 1935.	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	158,938	...	...	.	..	..	158,938	...	
...	...	...	...	...	...	...	...	248,730	...	248,730	1907-08 to 1926-27.	
...	...	...	...	...	...	...	20,886	...	...	20,886	1908-09 to 1927-28.	
...	...	...	...	...	...		20,886	248,730	...	269,616	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	

Name of Province.	Name of Conservator's Circles.	FOREST DIVISION. Name of Forest Division.	Class of Forests.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
										BURMA
Burma (Upper)—*concld.*	Southern Circle—*concld.*	Minbu	Reserved	255,239	485,171	740,410	Taungdwingyi Reserve.	.....	3	...
			Unclassed	...	840,366	840,366				
		Total	...	255,239	1,325,537	1,580,776	...	.....	...	...
		Pyinmana	Reserved	658,885	18,078	676,963	Yeni Reserve	.....	1	...
							Minbyin Reserve	.....	1	...
							Yonbin Reserve	.....	1	...
							Sinthe Reserve	.....	1	...
							Ngamaik Reserve	.....	1	...
			Unclassed	21,760	1,194,880	1,216,640	Yantungmyin, Kaing and Palwe Reserve	.....	1	...
							Taungnyo Forests	.....	1	...
							Pozaung daung Reserve.	.....	1	...
							Ziyaing Mehaw Reserves.	.....	1	...
		Total	...	680,645	1,212,958	1,893,603	.....	.....	...	...
		Southern Shan States.	Reserved	...	172,800	172,800	.....	.....	...	...
			Unclassed	...	8,038,400	8,038,400	.....	.....	...	...
		Total	...	...	8,211,200	8,211,200	...	.....	...	...
		GRAND TOTAL (Southern Circle.)	...	1,364,438	23,158,642	24,523,080	.....	.....	...	...
		GRAND TOTAL (Burma.)	...	3,603,130	79,888,321	83,491,451	.....	.....	...	...
Baluchistan.	...	...	Reserved	...	179,469	179,469	.....	.....	...	...
		Total	...	...	179,469	179,469	.....	.....	...	...
Andamans.	...	...	Reserved	...	101,930	101,930	.....	.....	...	...
			Unclassed	...	1,148,149	1,148,149				
		Total	...	...	1,250,079	1,250,079	.....	.....	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Clear Felling by Compartments with Artificial Regeneration.	Clear Felling by Strips.	Uniform Method or Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks
—*concld.*												
...	...	..	...	...	...	...	...	255,239	...	255,239	1907-08 to 1926-27.	
..	...	...	...	...	...	...	...	255,239	...	255,239	...	
...	...	...	...	50,363	...	...	...	...	...	50,363	189[illegible] to 1927.	
...	...	...	...	131,965	...	...	...	...	...	131,965	189[illegible] to 1929.	
...	...	...	...	81,295	...	...	...	...	...	81,295	1900 to 1930.	
...	...	...	...	67,963	...	...	...	...	...	67,963	1902 to 1932.	
...	...	...	...	80,[illegible]5	...	...	...	...	...	80,[illegible]5	19[illegible]2 to 1932.	
...	...	...	...	123,762	...	...	...	...	...	12[illegible],762	903 to 1933.	
...	...	...	...	67,997	...	...	...	...	...	67,997	1901 to 1933.	
...	...	...	...	52,011	...	...	...	...	...	52,011	1903 to 1943.	
...	...	...	...	24,704	...	...	...	...	...	24,704	1903 to 1923.	
...	...	...	...	680,645	...	...	...	...	...	680,645	...	
...	...	...	...	...	...	...	...	...	...	..		
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	..	...	...	...	
...	...	...	...	839,583	...	...	20,886	503,969	...	1,364,438	...	
...		...	...	3,057,726	...	...	20,886	518,010	6,508	3,603,130	...	
...	...	...	...	...	...	...	...		...	...		
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	..	...	...		
...	...	...	...	...	...	...	...	...	...	...		

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with	Number of Working Circles.	Number of Felling Series.
								SUMMARY OF TOTALS		
N.-W. F. Provs.	...	Total .	...	151,279	...	151,279	.....	.....	...	...
Punjab.	...	Total .	...	2,568,376	3,280,524	5,848,900	.....	.....	...	...
United Provinces.	Western Circle.	...	...	1,237,807	47,194	*1,285,001	.....	.....	...	...
	Eastern Circle.	...	...	1,161,853	217,634	1,379,487	.....	.....	...	...
		Total .	..	2,399,660	264,828	2,664,488	.....	.....	...	...
Bengal.	...	Total .	...	3,256,393	1,241,986	4,498,379	.....	.....	...	...
E. B. & Assam.	...	Total .	...	706,786	18,002,873	18,709,659	.....	.....	...	...
Central Provinces.	Northern Circle.	...	.	2,496,906	2,219,968	4,716,874	.....	.....	...	...
	Southern Circle.	...	...	3,582,203	1,296,706	4,878,909	.....	.....	...	...
	Berar Circle.	...	...	1,400,769	3,085,049	4,485,818	.....	.....	...	...
		Total .	...	7,479,878	6,601,723	14,081,601	.....	.....	..	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Stripe.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
BY PROVINCES.												
...	...	..	...	114,412	...	...	29,118	7,749	...	151,279	...	
..	...	...	47,595	1,399,911	...	74,124	466,662	408,943	171,131	2,568,376	...	
...	...	87,966	879	274,980	...	7,348	55,695	522,060	288,879	1,237,807	...	* Includes 7,977 acres of Unclassed Forest in the Sewalik and Jaunsar Divisions.
...	...	...	...	419,070	...	...	162,130	232,295	348,258	1,161,853	...	
...	...	87,966	879	694,050	...	7,348	217,825	754,455	637,137	2,399,660	...	
...	...	24,736	...	677,526	...	...	75,052	788,137	1,690,942	3,256,393	...	
...	...	...	...	591,212	...	...	64,380	51,194	...	706,786	...	
21,523	...	...	...	15,971	...	...	536,719	950,386	972,307	2,496,906	...	
...	...	...	...	19,575	...	...	165,309	889,940	2,507,379	3,582,203	...	
2,994	...	...	...	...	...	...	...	799,775	598,000	1,400,769	...	
24,517	...	...	...	35,546	...	...	702,028	2,640,101	4,077,686	7,479,878	...	

Name of Province.	Conservator's Name of Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	AREA IN ACRES. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
										SUMMARY OF TOTALS
Coorg.	...	Total .	...	113,727	219,199	332,926	... .	.. ...	...	...
Ajmer-Merwara.	...	Total .	...	89,780	4,485	94,265	... ..	.....	...	...
Burma.	Pegu.	...	...	1,070,485	19,251,990	20,322,475	... .	.....	...	...
	Tenasserim.	...	...	1,143,887	19,117,126	20,261,013	... ..	.....	...	...
	Northern Circle.	...	...	24,320	18,360,563	18,384,883	.....	... .	.	...
	Southern Circle.	...	...	1,364,438	23,158,642	24,523,080	.....	... ..	..	...
		Total .	...	3,603,130	79,888,321	83,491,451	.....	.....	.	...
Baluchistan.	...	Total .	...	...	179,469	179,469	...	.....	...	...
Andamans.	...	Total .	...	...	1,250,079	1,250,079	.....	.....	...	...
		GRAND TOTAL	...	2,369,009	110,933,497	131,302,506	.....	.....		...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Forest Storeyed Method.	Simple coppice Method	Coppice with Standards Method.	Method of improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
BY PROVINCES—*concld.*												
...	...	...	...	43,651	...	...	...	41,912	28,164	113,727	...	
...	...	...	...	...	...	...	41,101	...	48,679	89,780	...	
...	...	...	...	1,070,485	...	...	...	...	...	1,070,485	...	
...	...	...	...	1,123,338	...	...	...	14,041	6,508	1,143,887	...	
...	...	...	...	24,320	...	...	...	...	...	24,320	...	
...	...	...	...	839,583	...	...	20,886	503,960	...	1,364,438	...	
...	...	...	...	3,057,726	...	...	20,886	518,010	6,508	3,603,130	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
24,517	...	11,702	48,474	6,614,034	...	81,482	1,617,052	5,210,561	6,660,247	20,369,069	...	

Table II.

COMPARATIVE STATEMENT OF PROGRESS MADE IN WORKING PLANS UP TO 31ST DECEMBER 1908.

Comparative statement of progress made in working plans up to 31st December 1908.

Province.	Areas for which working plans have been completed and sanctioned.		Areas for which working plans are being compiled.		Area for which working plans have still to be taken in hand.	Total forest area.	Remarks.
	At commencement of the year 1908.	During the year 1908.	At commencement of the year 1908.	Taken in hand during the year 1908.			
	Sq. M.	Sq. M.	Sq. M.	Sq. M.	Sq. M.	Sq. M.	
Bengal	5,088	...	295	...	1,645	7,028	
United Provinces. — Eastern Circle	1,815	...	...	34	306	2,155	
United Provinces. — Western Circle	1,857	78	...	...	73	2,008	
Punjab	4,013	...	362	...	4,764	9,179	
Burma — Pegu Circle	1,672	..	...	...	30,082	31,754	
Burma — Tenasserim Circle	1,187	601	265	...	29,605	31,658	
Burma — Northern Circle	38	...	716	276	27,697	28,727	
Burma — Southern Circle	1,311	820	663	315	35,208	38,317	
Eastern Bengal and Assam	1,103	...	199	158	27,775	29,235	
Central Provinces. — Northern Circle	3,902	...	939	...	2,529	7,370	
Central Provinces. — Southern Circle	5,510	57	...	...	2,026	7,623	
Central Provinces. — Berar Circle	2,189	...	...	...	4,820	7,009	
Coorg	178	...		...	342	520	
North-West Frontier	185	51	...	...	...	236	
Ajmer	140	...	..	...	8	148	
Baluchistan	..	...	..	.	280	280	
Andamans	..	...	317	...	...	1,953	
Total Bengal	30,218	1,607	3,756	783	168,796	205,160	
Madras — Northern Circle	2,281	255	602	1,074	2,599	6,811	
Madras — Central Circle	2,177	248	1,724	536	2,558	7,243	
Madras — Southern Circle	2,167	101	593	6	2,686	5,553	
Total	6,625	604	2,919	1,616	7,843	19,607	
Bombay — Northern Circle	1,787	2	64	...	707	2,560	
Bombay — Central Circle	2,280	52	414	96	2,264	5,106	
Bombay — Southern Circle	920	25	204	64	3,379	4,592	
Bombay — Sind Circle	1,032	...	...	...	73	1,105	
Total	6,019	79	882	160	6,423	13,363	

Table III.

STATEMENT SHOWING AREAS BROUGHT UNDER THE CONTROL OF SANCTIONED WORKING PLANS UP TO 31ST DECEMBER 1908.

Areas brought under the control of sanctioned working plans up to 31st December 1908 in the provinces outside the Madras and Bombay Presidencies.

Province.	Forest area in square miles.				Area for which working plans prepared and sanctioned up to 31st December 1908.	Proportion of forest area under sanctioned working plans.
	Reserved.	Protected.	Unclassed State.	Total.		
					Sq. M.	Per cent.
Bengal	4,235	2,793	...	7,028	5,083	72
United Provinces . .	4,091	30	42	4,163	3,750	90
Punjab	2,176	5,241	1,722	9,139	4,013	44
Burma	22,859	...	107,597	130,456	5,629	4
Eastern Bengal and Assam	6 556	4	22,675	29.235	1.103	4
Central Provinces including Berar.	21,999	...	3	22,002	11,688	53
Coorg	520	...	..	520	178	34
North-West Frontier .	236	...	...	236	236	100
Ajmer.	142	...	6	148	140	95
Baluchistan . . .	280	..	...	280	.	...
Andamans . . .	159	..	1,794	1,953	...	...
Total .	63,253	8,068	133,839	205,160	31,825	15·5

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Forest Pamphlet No. 10 Forest Economy Series No. 3

BURMESE LEZA WOOD

(LAGERSTRŒMIA TOMENTOSA, Presl.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

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SUPERINTENDENT GOVERNMENT PRINTING, INDIA

1909

Lagerstroemia tomentosa, Presl.

Vernacular Name.—*Lega* (Burmese).

Locality.—Burma.

NOTE ON

BURMESE LEZA WOOD.

(LAGERSTRŒMIA TOMENTOSA, Presl.)

Vernacular.—Leza (Burmese).

1. Distribution and Habitat.

The tree is found throughout the greater part of Burma in suitable localities. It prefers the moister types of upper mixed, evergreen and semi-evergreen, and low-lying plains forests. In the drier types of forest it is either absent or found only in stunted form. It is one of the commonest companions of *Pyinkado* (*Xylia dolabriformis*) in the moister types of upper mixed forest, where it prefers the lower slopes and well drained valleys where the soil is good.

2. Description of Tree.

The Leza is a large tree, reaching a height of over 100 feet and a girth of 10 to 12 feet or more in favourable localities, the bole being usually straight and clean to a considerable height.

The bark is light grey, fairly smooth, and about $\frac{1}{4}$ of an inch thick. Natural reproduction is, as a rule, very fair. No attempts have yet been made to raise the tree artificially.

3. Description and Properties of Wood.

Colour, grain, etc.—The wood is light grey to greyish brown, moderately hard, close-grained, with a satiny lustre. The pores are distinct, and the medullary rays are very fine. Mr. Herbert Stone, of Birmingham, has reported as follows on a sample of the wood which was sent to him :—

"**Lagerstrœmia tomentosa**, Presl., is unknown here. Its chief merit is its satiny lustre, but it is rather cross-grained and brittle. I do not think that it will find a market in Europe, as the wood it most resembles, the American Birch, *Betula lenta*, will prove too strong a competitor, being obtainable of equal quality at thirteen pence per cubic

Forest Division.	Government duty.	Local market rate.	Approximate rate at which timber could be extracted.
Mundalay .	R5 per ton	R60 per ton (converted).	R10 per log 18′ × 4′6″ } At local Railway Stations. R40 per ton (converted) } At local Railway Stations. R15 per log 18′ × 4′ 6″ } At Rangoon. R50 per ton (converted) } At Rangoon. These rates are exclusive of duty.
Pyinmana .	R5 per ton in the round.	.....	R35 per ton (converted) on the Railway.
	R10 per ton converted.	.....	R8 per ton (round) on the railwny.
	Felling fee R2-8 per tree additional in reserves.	.....	R10 per ton extra for delivery in Rangoon. These rates are exclusive of duty.
Toungoo .	R8 per ton .	R16 to 18 in the round, at Railway stations.	At Nyaungbintha R7 per ton (in the round). At Swa R8-10-0 per ton (in the round).
		Scantling prices. 6″ × 3″ × 18′ R50 per 100.	At Myohla R8-10-0 per ton (in the round).
		5″ × 2″ × 18′ R80 per 100.	At Okwin R8-12-0 per ton (in the round).
		5″ × 3″ × 18′ R80 per 100.	At Rangoon – About R4-6-0 per ton more than the above rates.
		6″ × 2″ × 18′ R80 per 100.	These rates are exclusive of duty.
		6″ × 3″ × 18′ R80 per 100.	
		7″ × 3″ × 18′ R80 per 100.	

Forest Division.	Government duty.	Local market rate.	Approximate rate at which timber could be extracted.
		8″×2″×18′ R100 per 100.	
		10″×2″×18′ R100 per 100.	
		10″×3″×18′ R100 per 100.	
		12″×2″×18′ R100 per 100.	
Tharrawaddy	R5 per ton	.....	R30 per ton (converted) at Letpadan, Thonze, and Minhla Railway stations, (exclusive of duty).
Zigon	Ditto	.....	R7 to R8 per ton at Nattalin, Zigon, Gyobingauk and Okpo Railway stations.
			R10 to R11 per ton in Rangoon (round timber).
			These rates are exclusive of duty.
Prome	Ditto	...	R40 per ton (converted) at Prome.
			R50 per ton (converted) at Rangoon.
			These rates are exclusive of duty.
Bas-sein	Ditto	R50 per ton (average for converted timber).	R50 per ton (converted) at Bassein Railway station or *f. o. b.* Bassein Port inclusive of duty and extras.
Thaungyin	R8 per ton	.....	Cost of extraction in the round to Moulmein is estimated at R11 per ton. The cost of sawing is as follows :—

Forest Division.	Government duty.	Local market rate.	Approximate rate at which timber could be extracted.
			18′ × 6″ × 3″ at R75 per 100.
			18′ × 5″ × 2″ at 35 per 100.
			18′ × 4″ × 2″ at R30 per 100.
			18′ × 6″ × 1″ at R25 per 100.
			18′ × 5″ × ½″ at R20 per 100.
			18′ × 3″ × 1″ at R12·8 per 100.
			Cost of carriage to Paan R6 per 100 planks.
			Duty is extra.
Ataran	R8 per ton	R35 to R60 per ton (converted).	.....

7. Uses of the Wood.

Leza-wood is used for house-building (posts, scantlings, flooring, walling and doors), dugout canoes, carts, shafts and wheels, yokes, and furniture. It is also said to be used for bows and spear handles. The wood is at present under trial for railway sleepers, after treatment with preservatives. Leza-wood appears to be an admirable one for box-manufacture, and is worthy of attention by manufacturers of tea boxes and other forms of packing cases as well as boxes of a better class.

Leza-wood has recently been tried for match manufacture by the peeling process, and has been found to produce good splints as well as veneers for outer and inner boxes. The wood requires to be boiled for 10 hours before use. The splints, like those of many other woods, tend to become darker on exposure to the sun, and should therefore be dried either in shade or in a special drying apparatus.

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Forest Pamphlet No. 11 Forest Economy Series No. 4

CARALLIA WOOD

(CARALLIA INTEGERRIMA, DC.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
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CARALLIA WOOD

(CARALLIA INTEGERRIMA, DC.)

BY

R. S. TROUP, F.C.H.,

Imperial Forest Economist to the Government of India

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1909

Carallia Integerrima, DC.

Syn. *C. lucida*, Roxb.

(No English Name.)

Chief Localities.—Sub-Himalayan tract, Eastern Bengal, Assam, Chittagong, Chota Nagpur, Orissa and the Circars, W. Ghats, Burma.

NOTE ON

CARALLIA WOOD.

Carallia integerrima, D. C. ; Syn. *C. lucida,* Roxb., *C. ceylanica,* Wight. Natural order *Rhizophoreæ.*

1. Vernacular Names.

Maniawga, Burm. ; *Awga,* Upper Burma ; *Bya,* Arracan ; ***Kiabanj,*** (Beng.) Chittagong ; *Thekratenga, kujitekra, kujithakra, kujithakara, kanthekera, rata,* * Ass. ; *Kujikaor,* Garo ; *Kierpa,* Beng. ; ***Palamkat,*** Nep. ; ***Jur,*** ara mata, Kôl ; *Shengali, panasi,* Mar. ; ***Andipunar,*** *andipunai, andamargal, andamuria, andinaru,* Kan ; ***Punschi, makadchi-rand,*** Bombay ; *Karulli,* Tel. ; *Varanga, vallayam,* Mal.

2. Distribution and Habitat.

The tree is found in damp evergreen and swamp forests in the Sub-Himalayan tract, as far west as Dehra Dun, very scarce in the west, commoner in the east ; Bengal (up to 4,000 ft. in Sikkim), Assam, Khasia Hills, Chittagong, Chota Nagpore, Orissa and the Circars, Western Ghats, Burma, chiefly in the moister parts of Pegu and Tenasserim.

The tree is typically found in moist or evergreen forests, often occurring along the banks of streams in shady localities. It is nowhere abundant, and in many localities is very rare. In the *Western Ghats* it occurs in evergreen or semi-evergreen forests and along streams ascending to about 2,500 ft. Mr. R. S. Pearson reports that it is found in small quantities all over the evergreen forests of Kanara, especially in Kumta and Ankola, up to 1,500 feet, the top of the Ghats. In Belgaum it is reported scarce. Mr. W. A. Talbot states that the tree is very scarce in the Central Circle, Bombay. In the *Madras Presidency*

* ***Rata*** is the name given to many species of trees with red wood, which have botanically nothing in common.

it is rare. In the South Kanara District Mr. B. H. Barlow-Poole reports it to be scattered all over the district except at the Ghats. In Ganjam it is reported to be so scarce as to be practically non-existent. Elsewhere it is either extremely rare or is not found at all.

In *Bengal* the tree is found in several Forest Divisions, but is nowhere common. In *Eastern Bengal and Assam* it is found in the Kamrup, Cachar, Darrang, Nowgong, Sibsagar, Lakhimpur, Goalpara, Garo Hills and Chittagong Divisions. It occurs in damp localities and evergreen forests of the plains and lower hills up to about 2,000 feet. It is rare in most Divisions, but fairly common, according to Mr. E. M. Coventry, in Darrang. In Chittagong Mr. Heinig states that it is found in Cox's Bazar Sub-division and eastward into the hill tracts at 20—500 feet elevation, in mixed evergreen high forest, commencing from the high land behind the mangrove swamps. In Kamrup Division Mr. D. P. Copeland reports that it occurs on damp aspects at the foot of the Khasi Hills, especially on the lower hill slopes of the Myang Hill Reserve and Bardwar Reserve in evergreen forest up to an elevation of 500 feet. In the preliminary working-plan report for the Sal forests of Kamrup Division, on the south bank of the Brahmaputra, Mr. Copeland states that the tree forms part of the stock of evergreen forests and bamboos, in which Sal is absent; in these forests are to be found the sites of old *Jhums*, * which can be easily distinguished from the surrounding forest. The crop includes *Dendrocalamus Hamiltonii*, *Teinostachyum Dullooa*, *Mesua ferrea*, *Ficus elastica*, *Baccaurea sapida*, *Eriobotrya sp.*, *Licuala peltata*, *Macaranga spp.*, *Machilus spp.*, *Eugenia formosa*, *E. cymosa*, canes, etc. It is sometimes planted by the villagers in Assam for the sake of its fruit.

In *Burma* the tree is found in moist and evergreen forests, and on banks of streams, in Pegu and Tenasserim. In the lower mixed forests it is associated with *Dillenia pentagyna*, *Schleichera trijuga*, *Anogeissus acuminata*, *Lagerstræmia Flos-Reginæ*, *L. tomentosa*, *Diospyros ehretioides*, *Albizzia odoratissima*, *A. procera*, *Careya arborea*, *Dipterocarpus alatus*, etc. Its distribution in Upper Burma, where Brandis states that it is found, has not been ascertained. The forest Divisions in which it is reported to occur are Pegu, Rangoon, Tharrawaddy (chiefly in the south of the district), Bassein (low-lying hills and plains forests on

* Shifting cultivation.

both sides of the Yomas), Thayetmyo (moist parts of the East Yoma, Satsuwa and Tindaw Reserves), Toungoo, Shwegyin, Thaungyin, W. Salween, Ataran, and South Tenasserim. Kurz, in his Preliminary Report, mentions that it is frequent in Pegu and Tenasserim up to 4,000 feet on metamorphic rocks, sandstone and permeable laterite, in evergreen tropical and upper mixed forests. Although locally common in suitable localities, it is nowhere very abundant.

3. Description of Tree.

Carallia integerrima is a moderate sized to large handsome evergreen tree, with foliage of shiny thick elliptic leaves, and characteristically opposite branchlets. The bark is about $\frac{3}{8}$" to $\frac{5}{8}$" thick, the outer dead bark being corky and of a dark grey to pinkish colour, and the inner living bark pale greenish-yellow or pinkish when fresh-cut, turning orange-brown on exposure; on the inner surface of the cortex the ends of the numerous broad medullary rays are conspicuous as vertical streaks. These ends of the medullary rays are also very conspicuous as vertical streaks on the outer surface of the sapwood when the bark is stripped off. The tree often produces aërial roots, showing its connection with the mangroves. It produces coppice-shoots and root-suckers readily, and although it is sensitive to frost it has good powers of recovery. As a rule natural reproduction is reported to be good where the tree occurs, but possibly the reproduction may consist partly of root-suckers. Artificial reproduction by seed is carried out on a small scale in Assam by villagers, who cultivate the tree for the sake of its fruit. Mr. E. M. Coventry states that villagers in Darrang Division have successfully tried reproducing it by planting root-suckers.

In Burma the tree ordinarily grows to a height of 50—80 feet with a girth of 6 or 7 feet, and a clear bole of 40—50 feet. Logs of 50—60 cubic feet can be obtained. In Assam it is as large or nearly as large, but in Bombay and Madras it reaches a height of only about 40 feet, with a girth of 4 feet (exceptionally 6 feet) and a clear bole of 20 feet.

4. Description of Tree.

Grain, colour, etc.—*Sapwood* large, pink or light chestnut-brown, often with a yellow tinge. *Heartwood* red or chestnut-brown. The wood is hard and beautifully grained, the large medullary rays, when the wood

is cut in a radial direction, producing a very handsome silver-grain like that of a good quartered oak, which the wood much resembles. The large pores are often filled with a resinous substance, this being particularly noticeable in the sapwood when the tree is freshly felled. The wood seasons well and does not warp, but is sometimes apt to crack, during seasoning, along the medullary rays. As it should always be cut in that direction, however, to show the silver-grain, this is not always a serious objection.

A sample sent to a furniture-manufacturer in India was much admired, and was reported to be very easy to work and well adapted for ornamental furniture.

Weight.—The weight per cubic foot of seasoned wood has been determined with regard to the following specimens :--

No. in Dehra Dun collection.	Whence received.	Weight in lbs. per cubic foot (seasoned wood).
308	Burma (1867)	47
743	S. Kanara (Cherry)	42
816	Burma (B. Ribbentrop) . . .	51
4489	Ré Nadi, Dehra Dun (J. S. Gamble) . .	48
4508		42
5284	Rangoon Division, Burma (A. Rodger) .	46
5291	Ré Nadi, Dehra Dun (R. S. Troup) . .	42
	Average .	45

These specimens all contain sapwood as well as heartwood. A cylinder of green wood cut in 1908 weighed 69·2 lbs. per cubic foot, and the sapwood and heartwood cut from the same log and weighed separately, scaled 68·6 and 73·5 lbs. per cubic foot respectively. After seasoning the above the pieces each weighed 42 lbs. per cubic foot. Specimen No. 5291 above was cut from this log.

Strength.—The following are the results of tests carried out by Professor W. C. Unwin in 1899 and Professor W. H. Everett in 1908,

the former with Ceylon wood and the latter with Burmese wood from Rangoon Division :—

	Unwin.	Everett.
Resistance to shearing along the fibres (tons per sq. in.)	0·48	0·79
Crushing strength along the grain (tons per sq. in.)	2·670	4·07
Bending (transverse) strength (tons per sq. in.)	4·83	5·1
Stiffness, from bending tests, E, (tons per sq. in.)	561·3	565
Corresponding P *	601	634

Other values of P, from experiments, are 797 (Benson), 656 (Skinner), and 700 (Bourdillon).

Durability.—Carallia wood is said to be only fairly durable, and not to last well if exposed to the weather or in contract with the ground. For indoor work, however, it is quite suitable. Mr. R. S. Pearson reports that a log which had lain on the ground for two years in North Kanara was not found to be attacked by insects, and was still in a sound condition.

Herbert Stone's Description.—A sample of Carallia wood from Burma was sent to England in 1908 to Mr. Herbert Stone, who has kindly favoured me with the following report on it :—

"This is an attractive wood, strongly resembling European Oak in colour and figure. Few persons would be able to distinguish it from that wood when quartered. Unfortunately it is extremely brittle and hence unsuitable for many purposes, besides being very troublesome to work. Not that it is hard to work, on the contrary, it saws and planes easily; but the difficulty of planing to a level surface, through pieces ripping out, is great, and one can never tell when one's work is done. This applies to the radial section more particularly, as it is the 'silver-grain' which chips. In turning, the same difficulty is met with; the 'silver-grain' flakes off here and there. The specimen is of better quality in point of colour and figure than samples which I have seen from Ceylon and Queensland, but they all share the same defect of brittleness. It does not come up to expectation when polished, unless some colour be added, as the pale 'silver-grain' becomes invisible,

* P, representing the transverse strength, is obtained from the formula $P = \frac{W \times L}{B \times D^2}$ where W is the breaking load, L the length of the bar between supports, in feet, and B and D, its breadth and depth in inches.

except when viewed in certain directions, and the red pores, so effective in the freshly planed wood, assume a dull appearance. Having regard to its mechanical qualities, it is an inferior wood. As a furniture wood it cannot compete with European Wainscot Oak. I suspect its durability, Watt notwithstanding, and I cannot understand Beddome's statement that it is 'tough' and 'brittle' as it can scarcely be both."

5. *System of Working, and Outturn.*

Carallia has not been specially worked in any of the localities in which it occurs, although it is cut in unregulated and selection fellings in common with other miscellaneous species. In South Kanara the tree is found in forest worked under coppice with standards, but it is not left as a standard. There has never been any regular market for the timber, the tree not being sufficiently plentiful. The chief source of future supply is Burma, where possibly some 500 logs could be obtained per annum, chiefly from the Toungoo, Tharrawaddy, Bassein, Rangoon, Pegu, Ataran and South Tenasserim Divisions. A limited supply could be obtained from the Darrang, Nowgong, Cachar and Lakhimpur Divisions of Assam, and possibly also from Chittagong, Kamrup, and Sibsagar Divisions. In Bombay and Madras the supply is extremely limited, though a small quantity might be obtained from North Kanara Division in Bombay.

6. Prices.

The following statement gives the duty rates and approximate prices of the wood in various localities:—

Locality.	Government duty.	Local market price.	Approximate rate at which the timber could be extracted.
Eastern Bengal and Assam.			
Kamrup Division	R2 per tree .	...	R1-4-0 per cubic foot, converted, at Gauhati.
Cachar „	...	10 annas per cubic foot in the round.	R1-6-0 per cubic foot, converted, at Silchar.
Darrang „	R2 per tree .	...	12 annas per cubic foot, at Tezpur steamer ghat.

Locality.	Government duty.	Local market price.	Approximate rate at which the timber could be extracted.
Eastern Bengal and Assam—contd.			
Nowgong Division	R2 per tree	...	
Sibsagar „	5 annas per tree	...	Not less than R1-8-0 per cubic foot, at Jamguri or Barpathar railway stations.
Lakhimpur „	6 annas per cubic foot.	...	R1-4-0 per cubic foot at Dibrugarh. R1-8-0 to R1-12-0 per cubic foot at Calcutta or Chittagong (converted timber).
Burma.			
Toungoo Division	...	R9 per log or ton.	(1) At Nyaungbintha R7 per log (about 18′×5′ girth). At Pyu R7 per log. At Oktwin R7-8-0 per log. In addition to the above cost there is a royalty of R1-8-0 per log of 4′ 6″ and over, and 12 annas per log 3′ to 4′ 6″ in girth. (2) Logs can be delivered at Rangoon (not f. o. b.) from Pyu at an extra cost of R4 per ton.
Ataran „	R1-8-0 per log 4′ 6″ and over, 12 annas per log 3′ to 4′ 6″.	...	...
Thaungyin „	Ditto	...	Extraction in the round to Moulmein is estimated to cost R9 per ton of 50 cubic feet.
South Tenasserim Division.	Ditto	...	...
Tharrawaddy Division.	Logs 4′ 6″ and over in girth, R1-8-0 each. Logs 3′ to 4′-6″ in girth 12 annas each.	R15 to R20 per ton in the round. R30 to R40 per ton, converted.	R30 per ton (converted) at Letpadan and Thonze railway stations.

Locality.	Government duty.	Local market price.	Approximate rate at which the timber could be extracted.
Burma—contd.			
Rangoon . .	Logs 4′ 6″ and over in girth, R1-8-0 each. Logs 3′ to 4′ 6″ in girth, 12 annas each.	...	...
Bassein . .	Ditto .	R5 per log. R30 per ton, converted.	R5 per log, or R30 per ton, converted, at Bassein station or port.
Bombay.			
W. D. Kanara .	R1-8-0 per khandy of 12½ cubic feet.	...	Extraction very difficult and costly. Chief supply from the 6 above-ghat villages round Muski.
N. D. Kanara .	Ditto .	...	R24 per ton of 50 cubic feet at Tavargatti, Southern Mahratta Railway. R28 per ton of 50 cubic feet at Kodibag (Karwar).
Madras.			
S. Canara . .	...	...	3 annas per cubic foot on the sea coast. Loading into country craft would be extra.

7. Uses of the Wood.

The wood is used for house-building (planking and house posts), furniture, rice-pounders (Burma), agricultural implements (Madras), and handles of spears and 'dahs' (Burma); it would be suitable for panelling, picture-frames, and other ornamental work if cut on a radial section to show the silver-grain. It has been tried and found very suitable for brush-backs.

Mr. B. H. Barlow-Poole says, with regard to the use of this wood in the Madras Presidency, that the people are afraid to use it owing to the superstition that it attracts fire, and that a building in the construction of which it has been used will one day catch fire; to obviate this they scorch it before use.

8. Minor Products.

The Burmese use the roots for medicinal purposes (F. J. Branthwaite), and the bark as medicine in dental and stomachic ailments. In Assam the fruit is eaten, and the pulp, dried in the sun, is used as a medicine in cases of dysentery and chronic malarial fever (D. P. Copeland and E. M. Coventry). In Bombay (Kanara) an oil is extracted from the seed and is mixed with or used as a substitute for ghee (G. E. Marjoribanks) and is also used on a small scale for lighting purposes (R. S. Pearson).

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PETWUN OR TRINCOMALI WOOD

(BERRYA AMMONILLA, Roxb.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

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PETWUN OR TRINCOMALI WOOD.

Berrya Ammonilla, Roxb.—(Syn. *B. mollis*, Wall.). Natural order Tiliaceæ.

Vernacular.—*Petwun*, Burmese; *Chavandalai, thirukkanamallay, kambamaram*, Tamil.

1. Distribution and Habitat.

Throughout Burma, in suitable localities. Also found in Ceylon, Little Coco Island (Prain). "Said to be found in Southern India, but wild trees have not been recorded. Often planted as a forest tree or for ornament" (Gamble). "Malabar, Travancore" (Brandis).

In Burma the tree is found from the Upper Chindwin and Katha Forest Divisions on the north to the Ataran Division (Amherst District) on the south; information given in this pamphlet regarding the tree refers only to Burma, except where otherwise stated. It is found fairly generally scattered in upper mixed deciduous forests, chiefly of the drier type, associated with Teak, *Terminalia pyrifolia*, *T. tomentosa*, *Dalbergia cultrata*, *Xylia dolabriformis*, and other species. It occurs also to some extent in *Indaing* forest and semi-*Indaing*, associated with *Dipterocarpus tuberculatus*, *Shorea obtusa*, and *Pentacme suavis*. It is also found in lower mixed deciduous forests of the plains, associated with Teak, *Taukkyan* (*Terminalia tomentosa*), *Pyinma* (*Lagerstræmia Flos-Reginæ*), *Hnaw* (*Adina cordifolia*), *Binga* (*Stephegyne diversifolia*), *Teinkala* (*Adina sessilifolia*), *Thitsein* (*Terminalia belerica*), *Nabe* (*Odina Wodier*), *Dwani* (*Eriolæna Candollei*), *Zinbyun* (*Dillenia pentagyna*), etc.

Enumerations made in 1903-1904 by the writer in the Satpôk, Sitkwin and Thindawyo Reserves of the Tharrawaddy Division in mixed deciduous plains forest of this type over an area of about 20 square miles showed the number of Petwun trees 3 feet in girth and over per 100 acres to be

69 in Satpôk, 4 in Sitkwin, and 57 in Thindawyo. The soil in these reserves, which are situated on flat country, consists of a rich loam, with occasional pans of clay on which tree growth is poorer than elsewhere. Mr. Walsh notes having observed the tree in dense evergreen forest.

2. Description of Tree.

The Petwun is a large tree with smooth pale thin bark. It commonly grows to a height of 60—80 feet and a girth of 6 feet. Logs 18 to 20 feet in length and 4 feet 6 inches in girth can ordinarily be obtained. The proportion of heartwood is about $\frac{4}{5}$ of the whole log in average sized mature timber.

Natural reproduction is reported to be good in most localities, and poor in others. Mr. Walsh states that in the Ruby Mines the tree has great difficulty in establishing itself, seedlings, or possibly rootsuckers, being plentiful round each tree but saplings and poles very scarce. In the Satpôk reserve, Tharrawaddy Division, I have noticed very good young growth of Petwun, the saplings appearing to establish themselves without difficulty; here, however, a good deal of felling has been carried out in the past, and the young growth has no doubt benefited by the opening of the canopy.

3. Description and Properties of Wood.

Grain, colour, etc.—Sapwood light yellowish brown, about one inch broad. Heartwood orange-red to dark red or reddish brown, very hard, close even and straight grained, with a lustrous surface and a "soapy" feel which lasts a long time after the wood is cut.

The pores are clearly visible to the naked eye. The medullary rays are hardly visible without a lens on a transverse section, but on a longitudinal radial section they are clearly visible to the naked eye. The wood turns very well, planes to an extremely smooth surface, and polishes beautifully, but is difficult to saw. It splits easily and with a straight surface, especially in a tangential direction.

Weight.—The weight per cubic foot of seasoned heartwood has been determined with regard to the following specimens:—

No. in Dehra Dun collection.	Whence received.	Weight in lbs. per cubic foot.
B. 288 . .	Burma	52
B. 327 . .	Burma	61
B. 1,420 . .	Tharrawaddy	65
B. 1,452 . .	Prome	65
B. 2,722 . .	Tavoy	63
B. 3,118 .	Burma	58
B. 5,275 . .	Pyinmana, Upper Burma, (C. B. Smales) .	58
B. 5,276 . .	Ruby Mines, Upper Burma, (H. L. P. Walsh)	66
B. 5,285 . .	Ditto ditto . .	65
	AVERAGE .	61

Strength.—Professor Unwin's experiments for the Imperial Institute, London, in 1899 with Ceylon wood, gave the following results:—

Resistance to shearing along the fibres .	830·3 lbs.	per sq. in.
Crushing stress	3·442 tons.	,,
Coefficient of transverse strength . .	6·898 ,,	,,
Coefficient of elasticity . . .	780·7 ,,	,,

The value of P.* has been determined at different times by various persons, and varies from 622 to 1,028 in recorded tests. The wood, as will appear from the above figures, possesses great strength and elasticity.

Seasoning power.—The wood seasons well, but it is advisable to season it in the log, to prevent the formation of small radial cracks, which are apt to form if the wood is converted green.

Durability.—Petwun wood is durable, and lasts well on the ground and in contact with water. Gamble reports that a specimen which had lain in Calcutta for 50 years was perfectly sound at the end of that time. The wood is reported not to be proof against teredo attacks in salt water.

*P, representing the transverse strength, is obtained from the formula $P.=\frac{W \times L}{B \times D^2}$ where W is the breaking load in lbs., L the length of the bar between supports, in feet, and B and D its breadth and depth in inches.

Herbert Stone's description.—Herbert Stone in his "Timbers of Commerce"* remarks as follows regarding this timber :—

> "Weight 48 to 65 lbs. per cubic foot. Hardness grade 3, very hard, compare Blackthorn. Smell and taste none. Burns with a lively crackling flame : embers glow in still air : ash pure white. Solution with water or alcohol colourless. *Grain* very fine, dense and even. Surface lustrous, the brightness being due to the ground tissue and the shining drops : feels slightly damp even when really dry : does not soil easily. Fissile, works very sweetly, finishes well, is of good appearance, splits easily, straight and cleanly. I have not heard of this wood being sold in England, but it is one that deserves attention from its many excellent qualities."

4. System of Working.

Petwun, where worked for trade purposes, is extracted from unclassed forests under cover of prepaid licenses, and in the few cases where it is felled in reserves it is previously marked under the selection system. The timber, however, can hardly be said to have been worked with any regularity during the past. For domestic purposes it may be extracted without a license in unclassed forests. Extraction is carried out by dragging, carting, and rafting with the aid of bamboos. The construction of forest roads or other means of transport would facilitate extraction.

5. Outturn.

Figures for past outturn are not available, as Petwun timber is not separately classified. The future possible outturn also cannot be estimated with any degree of accuracy owing to the absence of enumerations and to the fact that the possible outturn will depend greatly on the extent to which roadmaking is carried out in future. The possible annual outturn for Burma will probably not exceed 1,500 tons per annum under existing conditions.

**The Timbers of Commerce and their Identification*, by Herbert Stone, F.L.S., F.R.C.I., London, W. Rider & Son, Limited, 134, Aldersgate Street, E.C., 1904, page 16.

6. Prices.

The following statement gives the duty rates and approximate prices of Petwun timber in various localities :—

Forest Division.	Government duty.	Local market rate.	Approximate rate at which timber could be extracted.
Myittha .	Full sized logs R1 each. Undersized logs 8 annas each. Posts R10 per 100. Poles 8 annas per 100.	R6 per ton (round)	R7 to R8 per ton (round) at Alon. R17 to R18 per ton (round) at Rangoon (inclusive of duty).
Mandalay .	R5 per ton . . .	R60 per ton (converted).	R10 per log 18′ × 4′ 6″. } At local railway stations. R40 per ton (converted). } At local railway stations. R15 per log 18′ × 4′ 6″ } At Rangoon. R50 per ton (converted) (exclusive of duty). } At Rangoon.
Pyinmana .	Duty 1 rupee per log of 4′ 6″ girth and over. 8 annas under that girth. Double the above rate for converted timber. For trees felled in reserved forests a small felling fee would be charged.	About R60 per ton for 1 inch planks.	(1) At Thawatti, Ela, Pyinmana or Kyidaunggan stations on the Burma Railway : In round, R8 per ton. } Not including duty. Converted R35 per ton. } Not including duty. (2) At Rangoon station : In round, R20 per ton. } Not including duty. Converted, R45 per ton. } Not including duty.
Ruby Mines	Logs 4′ 6″ and over in girth, one rupee each. Logs 3′ to 4′ 6″ in girth, 8 annas each. Posts 1′ to 3′ in girth, 4 annas each. Poles, 1 rupee per hundred.	.....	.....

6. Prices—*continued*.

Forest Division.	Government duty.	Local market rate.	Approximate rate at which timber could be extracted.
Tharrawaddy	Logs 4′ 6″ and over in girth, R1-8-0 each. Logs 3′ to 4′ 6″ in girth, 12 annas each.	R20 per ton in the round. R50 per ton converted.	R30 per ton (converted) at Letpadan, Thonzè and Minhla Railway stations.
Zigon . .	Logs 4′ 6″ and over in girth, R1-8-0 each. Logs 3′ to 4′ 6″ in girth, 12 annas each.	.....	R50 to R55 per 100 planks 18′ × 6″ × ¼″ and 18′ × 8″ × ¼″ at Nattalin, Zigon, and Gyobingauk Railway Stations. R18 to R20 per ton in the round at the same places. To Rangoon railway freights are as follows:—

From.	Freight per ton of converted timber.	Freight per ton in round.
	R a. p.	*R a. p.*
Nattalin .	3 14 0	3 7 9
Zigon . .	3 10 0	3 4 0
Gyobingauk	3 6 6	3 1 0
Okpo . .	3 3 0	2 13 9

Local charges such as cart hire and loading on the truck at R2 per ton for round logs and for converted timber at R1-8-0 per ton. The value at Rangoon will be the price per ton of converted timber or round log as mentioned below *plus* local charges and railway freight.

From R50 to R55 per 100 planks. Duty R1-8-0 per Du and R0-12-0 per Yat. R18 to R20 per ton for timber in the round.

Prome .	Ditto .	.....	R20 per ton in the round at Prome. R26 per ton in the round at Rangoon.

6. Prices—*concluded.*

Forest Division.	Government duty.	Local market rate.	Approximate rate at which timber could be extracted.
Bassein .	Logs 3′ to 4′ 6″ in girth, R1-8-0 each. Logs 3′ to 4′6″ in girth, 12 annas each.	About R6-8 per log 4′ 6″ and over in girth.	R6-8-0 per full-sized log at Bassein Port or Railway Station. R36 per ton (converted) at Bassein Railway Station. R35 per ton at Bassein Port.
Toungoo .	Logs 4′ 6″ and over in girth R1-8-0 each. Logs 3′ to 4′ 6″ girth 12 annas each. Posts 1′ to 3′ in girth 4 annas each.	R7 to R12 per ton for logs 4′ 6″ and over in girth. R3 each for house-posts about 2′ 3″ in girth and 18′ to 20′ in length.	At Nyaungchidauk, R6-10 per log 4′ 6″ by 20′. At Myohla, R10-10 per log 4′ 6″ by 20′. At Swa, R10-10 per log 4′ 6″ by 20′. At Yedashe, R7-0-0 per log 4′ 6″ by 20′. (2) At Rangoon (not *f. o. b.*) R4-8-0 per ton more than above prices.
Thaungyin .	Logs 4′ 6″ and over in girth R1-8-0 each. Logs 3′ to 4′ 6″ girth, 12 annas each. Posts 1′ to 3′ in girth—4 annas each.	.....	East of the Dawna Hills, where the tree is most plentiful, extraction is too difficult. West of the Dawna the cost of extraction to Moulmein is estimated at R9 per ton in the round.
Ataran . .	Ditto .	.....	.....

7. Uses of the Wood.

Petwun is used in Burma for house-building (posts, beams, scantlings, flooring, etc.) sampans, oars, ploughs, harrows and other agricultural implements, axe-handles, bodies, shafts, axles and yokes of carts, naves, spokes and felloes of wheels, spear handles, gunstocks, and Karen bows. In Madras it is used for masula surf boats and for carriage-building. The Ordnance Department uses it for draught-poles, sponge-staves, and hand-spikes.

Owing to its toughness, elasticity and straight grain Petwun wood is recommended for carriage shafts and other purposes requiring these

properties. It would probably be suitable also for paving blocks, though its smoothness might possibly be against it as forming too slippery a surface. It might be tried for cask staves, though its weight may be against it.

The Superintendent of Insein Jail states: "I consider it a most suitable wood for making shafts and wheels of carriages as well as for elegant furniture."

A sample of the wood was recently sent to a well-known fishing-rod manufacturer in London for trial in the manufacture of fishing-rods, but was unfavourably reported on.

8. Minor Products.

The bast fibre is sometimes used for cordage, but the quality is not very good.

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A NOTE

UPON

THE "BEE-HOLE" BORER OF TEAK IN BURMA.

BY

E. P. STEBBING, F.L.S., F.Z.S., F.E.S.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1905.

Note on the Bee-Hole Borer of Teak in Burma.

The accompanying three plates illustrating this note, together with their descriptions, are sent for favour of binding up with the note.

E. P. STEBBING.

The 20th May 1906.

PLATE I.

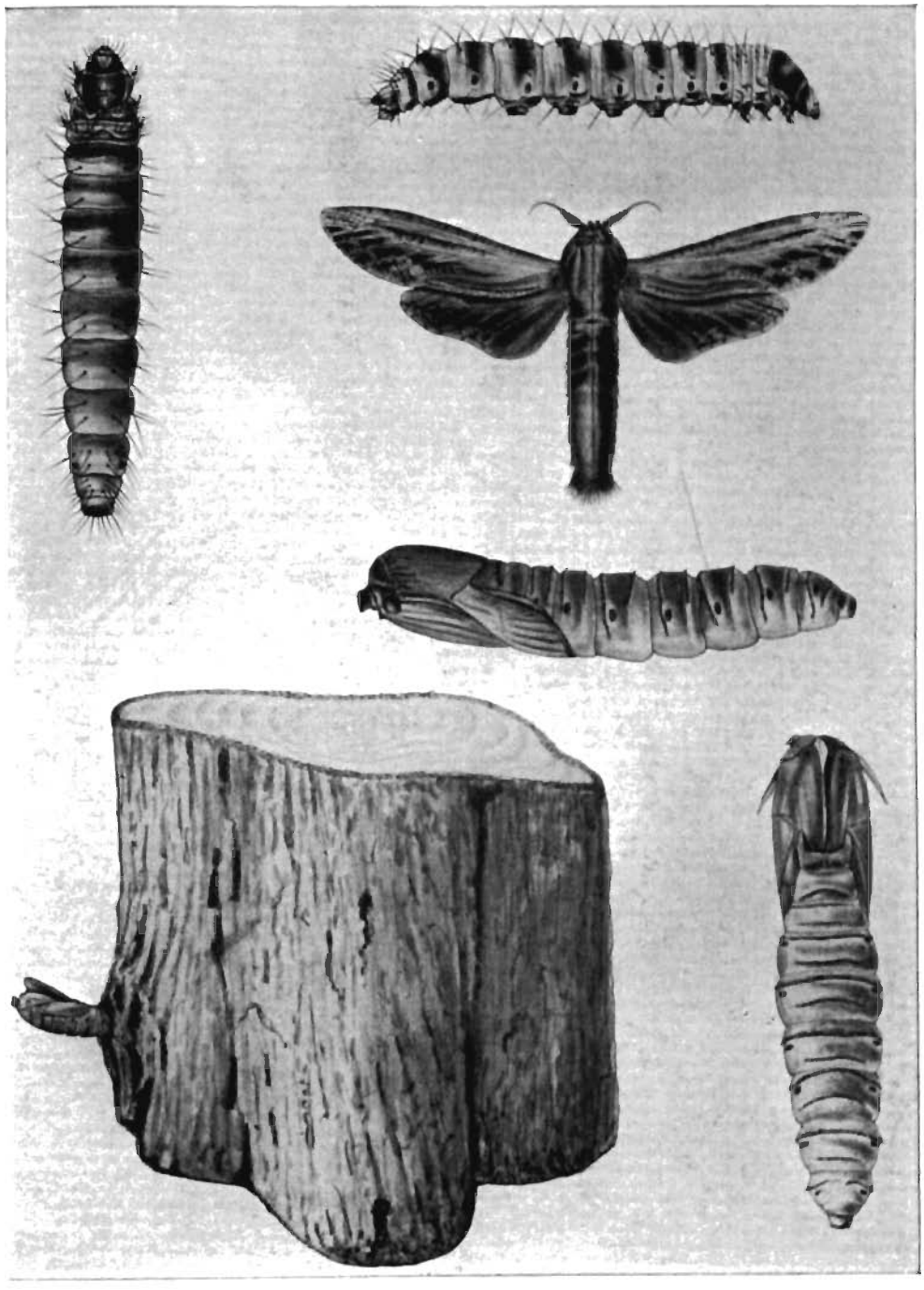
Fig. aa'.—Dorsal and side view of larva (caterpillar).

Fig. bb'.—Dorsal and side view of pupa (chrysalis).

Fig. c.—Moth.

Fig. d.—Section from lower part of a green standing teak tree showing a protruding pupal case *in situ* from which the moth has recently escaped ($\frac{1}{4}$th natural size).

NOTE.—Figs. aa', bb' and c are natural size.



THE "BEE-HOLE" BORER OF TEAK.

P.-M. & Litho. Dept., T. College, Roorkee.

PLATE II.

Portion of a stem of a standing green teak tree. The upper bark has been removed to show the irregular chamber made in the cambium and sap wood by the larva of the bee-hole borer of teak.

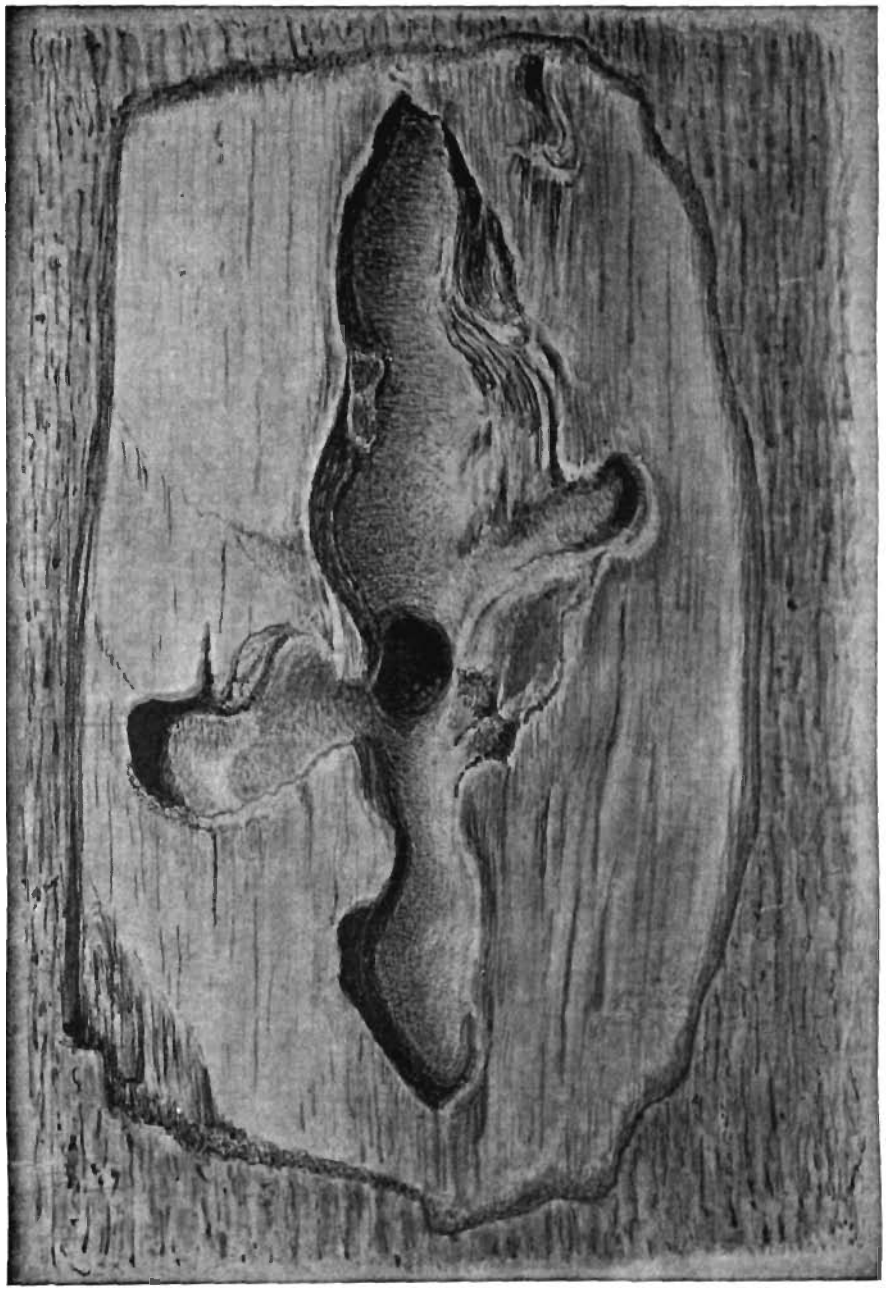


Photo.-Mechl. Dept., Thomason College, Roorkee.

Larval Galleries in Bark made by the Bee-hole borer of Teak.

PLATE III.

Section through a portion of a stem of a standing green teak tree showing the gallery made in the wood with the pupal chamber at its upper extremity and a pupa *in situ*. The strand of fibres across the mouth of the gallery is also shown (about $\frac{1}{4}$ natural size).

Photo.-Mechl. Dept., Thomason College, Roorkee.

Pupal chamber of the Bee-hole borer of Teak.

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A NOTE

UPON

THE "BEE-HOLE" BORER OF TEAK IN BURMA.

(DUOMITUS.)

I.—General.

FOR some years past Forest Officers and Timber merchants have noticed and reported that teak logs when cut up in the mill are occasionally found to contain holes and elongate tunnels of considerable size and roundish-oval in section, to which the popular name of "bee-hole" has been given. This name, so far as I can ascertain, appears to be a "trade" one and, as is often the case with popular nomenclature, is unsuitable since the holes have no connection whatsoever with bees. All teak timber is not affected in this manner, the trees in certain forests in different localities suffering more than those from others. Timber affected in this way is to be found all over Burma, but it is apparent that certain forests are more liable to contain "bee-holed" timber than others. For a considerable time the origin of these holes has been a mystery. It was attributed for the most part to an insect or insects, although various much wider surmises as to the cause have been advanced.

There are no two opinions, however, upon the damage done to the timber. Holes of all sizes are to be found right inside the large teak squares and greatly reduce the prices obtained for the wood or ruin it altogether. For instance "bee-holed" timber is quite useless for Admiralty purposes and attention was drawn to their presence in

the wood in the early days of Forest operations in Tenasserim. In his Report on the Teak Forests of Tenasserim Dr. H. Falconer, F.R.S., Superintendent of the Botanical Gardens, Calcutta, made the following allusions to this subject as long ago as 1851 :—"The mixture of this light dead timber, with unseasoned logs which have been felled green and logs flawed with holes and clefts from the Thaungyin, in the shipments made to England is generally considered to have been the cause of the bad repute into which the Tenasserim teak has fallen at home for shipbuilding.....The two latter circumstances had more to do with the result than the first." "The tree during its growth does not seem to suffer much from the ravages of parasitical insects. Captain Tremenheere mentions that the stem is attacked by a beetle in the Thangyin which bores teredo-like holes. I observed no marks of such an insect in the Ataran Forests."

Captain Guthrie, Superintendent of Forests in the Tenasserim provinces, wrote in a report dated 20th June 1845, "Of the Thaungyin teak I may remark that I have seen it growing and thriving in every variety of locality; it has generally the advantage of carrying its girth well to a great height, not tapering quickly; it appears to be somewhat liable to small cells, isolated, but which appear in sawing up."

The presence of these "bee-holes" in the wood has resulted in two serious drawbacks :—

(1) Reduction in the amount of timber available for export owing to the trees from certain localities having been found to be badly "bee-holed." This results in smaller amounts being available in the home markets.

(2) Serious losses to the merchant engaged in extracting the wood.

Under the latter head I have been supplied with the following figures (at Moulmein) :—

			₹	a.	p.
Value of good sound teak log, 24′ × 5′ middle girth free		from bee-holes . . .	160	0	0
Do.	do.	with a few bee-holes . .	92	8	0
Do.	do.	with numerous bee-holes . .	40	0	0
Do.	do.	entirely riddled . . .	7	0	0

(The log would be cut up and sold as firewood.)

Soon after my arrival in Burma I paid a visit to the Saw Mills of Messrs. Steel & Co. in Rangoon, where the manager very kindly showed me a number of attacked squares and, in fact, teak material of all sorts. An exceptionally badly riddled square was cut up in order that the tunnels might be traced from the orifice opening out on the outer surface to their extremities in the wood.

Two points were ascertained:—

(i) That the tunnel curved up the stem soon after entering and ended in a slightly wider chamber at its upper extremity. Its section was oval-elliptical.

(ii) That the tunnel did not necessarily open on to the outside of the squares. In taking off slabs with a circular saw it became apparent that tunnels both commenced and ended within the wood itself.

From an examination of the tunnel it was at once apparent that, although the work of an insect, it was not the work of one of the carpenter bees (*Xylocopa*). These bees usually work in colonies, the tunnels being placed closely adjacent and being invariably large in section and circular. Nor was it the work of a wood wasp (Sirex); the grub of the latter tunnels in a very irregular manner in the wood, the gallery running at various angles, and, in addition, there is always an exit gallery bored straight from the pupal chamber to the outside. This reduced the matter to three probable groups. Two of beetles, *Buprestidæ* and *Cerambycidæ* and one of the *Heterocera* or moths (the wood-boring families *Cossidæ*, *Arbelidæ*, etc.).

From my examination of the tunnels I was inclined to think they were either Buprestid or Heterocerous. The difficulty, however, was that the tunnels, though varying in size, were each individually of the same width throughout. In other words, the whole tunnel appeared to have been made by the *full grown* insect; whether in its larval or mature stage had yet to be ascertained. I could find no trace of the gradually increasing gallery made by a larva as it grows from its young to its full-grown condition; nor did there appear to be any separate exit gallery. These facts rather led to the

assumption that the insect was one of those which spend the whole of their grub stage (until full size is attained) feeding beneath the bark in the bast and sap wood, only boring into the wood to pupate, and this was a point to be evidently kept in view in studying the attack in the forest. The fact that the tunnels varied greatly in width was not of great importance since the individuals of many insects of one and the same species vary greatly in size, as also do the males and females of the same species.

The second of the above points was of great importance since it seemed to indicate that the tree had been attacked whilst alive and in a younger stage, the exit hole on the outside of the stem having been subsequently covered over by later layers of wood.

II.—Points to be studied.

My examination of the timber in Messrs. Steel & Co.'s Saw Mill enabled me to draw up the following questions which required answering from direct observations in the forest:—

(1) The exact position on the tree and direction of—

- (*a*) the entrance hole;
- (*b*) the main gallery;
- (*c*) the pupal chamber;
- (*d*) the exit hole;

(2) Where the eggs are laid.

(3) Length of time spent in the larval or grub stage and where and how the larva feeds.

(4) Length of time passed in the pupal or chrysalis stage and where this stage is passed.

(5) At what time of the year the insect quits the tree and how.

(6) The nature of the insect, whether wood wasp, carpenter bee, beetle (buprestid or longicorn) or a boring heterocerous (moth) caterpillar.

(7) Are green standing trees in the forest attacked?

(8) Are the trees only attacked after being girdled?

(9) Are dead trees attacked by the insect?
(10) At what age are the trees attacked?

III.—Tharrawaddy Teak plantation Thinnings.

"Bee-holes" in teak in the Tharrawaddy Division are said to be by no means common. We found, however, what Mr. Troup, the Divisional Officer, considered to be an example of such in an 1888 plantation in the Kadin Bilin Forest. In the light of subsequent investigations I am now able to corroborate Mr. Troup. This plantation had been thinned last year and the thinned trees were lying in the coupe, since the thinnings here are not sold. Whilst cutting up and examining one of these trees for *Scolytidæ*, with one or two species of which the wood was being riddled, we came upon a cavity or tunnel in the stem and traced it up to what appeared to have been a pupating chamber of an insect, situated in the long axis of the tree in the centre of the heart wood. The top of the tunnel or former exit hole of the pest had three rings of sap wood superimposed above it. It was therefore justifiable to suppose that the attack had been made upon the tree whilst still living, the entrance or exit hole having been closed up by the subsequent growth of the tree.

IV.—Examination of Timber from the Mohnyin Reserve in the Kadu Depôt, Katha Division.

On my arrival at Kadu in the Katha Division, Upper Burma, I examined a number of teak logs in the Depôt and also some standing dead girdled trees. The logs had all come from the Mohnyin Reserve, the teak trees of which were earning an unenviable notoriety owing to the number of "bee-holes" the timber contained. I found that a majority of the logs showed "bee-holes" on the outside as also sections of them on the cut ends. The holes were usually oval-elliptical in shape and appeared to vary greatly in size. Many were badly "weathered," the opening on the outside being

much enlarged, the enlargement being due to either moisture or to the attacks of wood-peckers searching for the grubs. The holes were either widely scattered, only two or three appearing on the outside of a tree, or there were several closely adjacent to one another. A careful examination of the holes and the tunnels into which they led disclosed the fact that these latter invariably curved upwards soon after leaving the outside. As already seen in the Saw Mill at Rangoon, the diameter of the tunnel was the same all the way up with the exception that the last 2—2½ inches were slightly enlarged. I had noticed in the wood examined in Rangoon that this enlarged area was often lined with a layer of calcareous matter, but this was not the case with the galleries examined here.

V.—Examination of Standing trees in the Mohnyin Reserve.

(*a*) *Dead Trees.*

Dead standing trees in the forest exhibit much the same appearance as the felled logs. The "bee-holes" are to be seen on the outside often "weathered" and enlarged and are also to be found inside the timber when cut up, the end of the hole having been closed over by subsequent growth of wood. In no instance, however, have I found fresh attacks, *i.e.*, fresh "bee-hole" borings, in dead trees; the holes in every case in this latter having all the appearance of having been made some time previously.

(*b*) *Girdled and dying trees.*

It was perhaps but natural that in the first instance one should entertain the opinion that there might be some connection between the custom of girdling the green standing teak trees and leaving them several years in the forest before extraction and the "bee-hole" attacks. Whilst, however, my examinations showed me that standing girdled dying trees contained the "bee-holes" both outside and also inside the wood, I found no evidence to prove that the holes in the wood were made by insects attacking the trees after they had

been girdled and whilst the bast and sap wood were slowly dying. In the case of the Sâl tree in India, and in fact of probably the majority of trees, girdling standing trees in the forest would almost certainly be followed by various species of wood-boring insects at once depositing their eggs in or beneath the bark and the resultant grubs would feed at first in the dying bast and sap wood and then, as they grew older, tunnel directly into the heart wood. The teak, so far as my observations go, appears to be an exception to this rule.

(*c*) *Green Trees.*

It was when I turned my attention to the examination of green standing trees in the Mohnyin Reserve that I commenced to understand the real position of affairs and to make the first of a series of observations which have led to the discovery of the true author of the "bee-holes" in teak, of their mode of origin and of a considerable portion of the life history of the "bee-hole" borer.

I have already shown that the "bee-holes" are to be found with their entire length and entrance (or exit) hole buried deep in the heart wood of the tree. We have also seen that quite small trees (16-year old), as instanced in the Tharrawaddy Plantations, may have a "bee-hole" in the wood entirely covered up by several later layers of sap wood. This led to the possible assumption that green trees were attacked by the author of the "bee-hole" and observations in the forest quickly showed that such was actually the case. Green trees showed the "bee-holes" on the outer surface of the bark in almost every stage of formation and age: the hole newly gnawed to the outside of the bark, from which sap was seen to be oozing and below which, either on projecting inequalities of the bark beneath the hole, or at the foot of the tree, saw dust and gnawed wood from the tunnel were to be found; older holes with the outer bark closing over them, the size of the external hole still present depending upon the age of the tunnel beneath; and finally trees in which the holes were entirely closed over, but which still betrayed, by the presence of a dark coloured or black point on the outside bark, the existence of a "bee-hole" beneath.

Once these outside evidences of the "bee-hole" have been fully recognised, the former presence or, as we shall see later, actual presence of this pest can be detected unerringly.

A discovery of a most serious nature was made whilst examining the trees in plantations in this reserve. It was proved beyond a possibility of doubt that the insect attacks trees of all sizes down to the youngest 2-year old sapling which contains at its base woody tissue.

VI.—The nature of the Insect which causes the "Bee-hole."

The discovery of fresh "bee-holes" in green trees led to the narrowing down of the possible authors of the damage and on splitting up some logs selected from a badly attacked green tree standing in the forest I obtained the "bee-hole" borer. It proved to be a large brightly marked caterpillar of the sub-order *Heterocera* or moths, thus discrediting its popular name of "bee-hole" and disposing of the much more probable theories that the holes were the work of one of the boring beetles belonging to the families *Buprestidæ* or *Cerambycidæ*.

VII.—The method of attack as determined from inspections of green, girdled and dead trees.

The egg is, I think, undoubtedly laid by the moth upon the bark,* or under a flake or ridge. If more than one egg is laid at any one spot only one develops, or, if more than one, the young caterpillars separate and bore into the bark at different spots. This is borne out by the fact that only one insect is found occupying the "bee-hole." The young larva on hatching out bores through the

* Since writing this, whilst inspecting the Shwegyin Plantation on the Salween river in Tenasserim, a patch of eggs which *may* prove to be those of this insect was discovered on the stem of a green teak. These eggs were flat, roundish and yellow, some 150 in number and laid close together in a blackish gummy substance which glued them on. Two moths had already issued from trees in this plantation. These eggs were taken on March 11th.

bark and feeds probably at first only in the bast, but later on, when its mandibles (biting-jaws) have become stronger, it eats into the sap wood as well. It bores an irregular shaped gallery having several irregularly-radiating arms, the total length being usually about four inches, with a breadth of three inches. As the grub becomes older it eats down into the sap wood, the depressions in the latter being deeper in the central part of the irregular shaped cavity. When full grown it bores into the heart wood and excavates a tunnel which curves upwards, is about nine to thirteen inches in total length, and is slightly enlarged at its upper end, the enlarged portion being from 1½ to 2 inches in length. This tunnel appears to usually start from the centre of the irregular depression, is of but slightly larger section than the body of the caterpillar and has the same width throughout, except at the upper end. The enlarged portion at the top is the pupating chamber and in it the caterpillar changes to the pupal or chrysalis stage, turning round so as to face *down* the hole before doing so. The tunnel is kept quite free of wood sawdust and excreta, these being ejected from it through a hole gnawed in the bark just over the entrance of the tunnel into the wood; the hole really forming a prolongation of the latter, but separated by the deep irregular depression in the sap wood. Before finally pupating the caterpillar again crawls up the tunnel and spins a close firm taut silken mesh across the tunnel just below the spot at which it opens out into the depression in the sap wood. It then proceeds backwards up the tunnel and spins a second of these meshes just below the point where the gallery opens out into the wider pupal chamber. The damage this insect does to the tree is then complete and the "bee-hole" in the wood has been made. An examination of all trees containing "bee-holes" on the outside will show the irregular depression in the sap wood. If the tree is dead, this depression may be considerably "weathered," but it is always distinguishable. If the tree is green and the external hole is nearly closed up, on shaving off the bark at the spot the layers of bast gradually closing over the depression and hole will be disclosed and beneath these the irregular depression with the entrance to the tunnel at or near the centre.

VIII.—Description of larva (caterpillar), pupa, chrysalis and moth.

Larva.—A large robust caterpillar consisting of a head and twelve segments; the latter swollen and distinct, skin shining with a satiny lustre. It tapers both anteriorly and posteriorly, the 12th or last segment being much smaller than the rest. Head small, shining, dark walnut-brown above and on sides; mouth parts black. First thoracic segment (the segment following the head) shining, light walnut-brown dorsally, with a truncate ovalshaped patch behind set with asperities and protuberances (probably to enable the grub to push out wood-dust particles from the tunnel); 2nd segment white with three tubercles placed transversely on each side of the dorsal median line; rest of segments to 11th inclusive satiny-white, with a broad transverse bright pink band on each, commencing just below the front edge of the segment and extending to about its middle; a large brown spot (spiracle) with a pink centre on each of the segments 2-11 (inclusive), just above the median lateral (side) line; 12th segment small, pink in front and a dirty-brownish black behind. A round black spot above and below each spiracle. Four small brown spots dorsally on each segment; two in the centre of the pink band one on either side of median line and the other two anteriorly on the white band set slightly laterally to the ones above them. These spots seem to partake of the nature of minute tubercles and may help the larva in its movements in the tunnel. Length $1\frac{3}{4}$ to 2 inches. All the segments with the exception of the 12th shining, with a satiny lustre. Under-surface satiny-white, as also are the three pairs of front legs (on the first three segments behind head) and the abdominal ones, the latter with well-marked clasping pads. Under-surface is flat, upper convex.

Pupa.—Stout, elongate, tapers slightly posteriorly. Chestnut-brown, darker at thoracic end; antennæ and wings of future moth distinctly visible as raised lumps on the pupal skin at the upper end. Colour lighter posteriorly; the abdominal segments canary yellow beneath and at sides, with narrow bands of this colour marking the intervals of the segments. The spiracles prominent as brown spots

on sides of abdominal segments. Under-surface lighter in colour, length 1½ to 2½ inches.

Moth.—A large moth with long and narrow wings. The head thorax and body pale ochreous brown, more or less suffused with black; patches of black scales at each side of hinder portion of thorax. Fore wing pale ochreous brown with blackish streaks and an irregular whitish patch in the outer angle which tails off in a series of decreasing spots. Hind wing fuscous, slightly marbled with black. Expanse of wings $4\frac{1}{6}$th inch.

The moth does not appear to have been taken in Burma since Hampson in the Fauna only gives the habitat as Sikkim; Nias; Ceram.

IX.—Probable Life History.

The egg is almost certainly laid upon the bark of the tree probably in the hot season before the monsoon bursts (*vide* footnote on p. 8). The caterpillar probably hatches out within a short period and feeds as I have shown in the bast and subsequently on the sap wood, finally pupating in the interior of the wood. It is probable that it only spends the monsoon months (with perhaps a portion of the preceding hot weather) in feeding and attaining its full size, and towards the commencement of the cold weather it tunnels into the tree. These conjectures are borne out by the fact that no half grown or smaller larvæ have been found in the irregular depressions beneath the bark and therefore it would appear that the insect passes through the whole of its life cycle from egg to moth in a year. Since a number of larvæ were found at the end of February at the top of the tunnels in the wood, but only one pupa, it appears that the cold weather is passed through in the larval stage in Upper Burma, perhaps partly in boring the pupating tunnel and chamber, and that the larva only changes to the pupal or chrysalid condition on the approach of the hot weather. I do not know as yet how long is spent in the pupal stage nor when the moth issues in Upper Burma, but the former is probably short, the latter issuing sometime during the hot weather. To enable the moth to issue, the pupa would work its way up the tunnel by means of the minute circles of spines situated

on each of the abdominal segments, rupturing the mesh nets spun across the tunnel near its upper end and near the mouth in its progress, and projecting, for about half its length from the hole bored by the larva in the bark.* The moth probably issues at night and flies and pairs at night. The life history will vary slightly in Upper and Lower Burma and again in Tenasserim.

X.—Enemies.

As far as my present observations have been carried, the chief enemies of the "bee-hole" borer would seem to be wood-peckers. I noted two species in Katha: the one blackish-green, the other greyish-green.

They are both called *Thit tauk lauk* by the Burmans. These birds "tap" the "bee-hole" tunnels by boring down through the wood, above the exit hole on the bark, until they reach the tunnel and the grub which is to be found at the end of it. They exhibit

* *Note 1.*—Since the above was written some teak areas and plantations on the Salween River have been visited in company with the Conservator. We inspected the Shwegyin plantation and searched for the borer. Mr. Manson pointed out *something protruding from the bark of one of the trees about eighteen inches up* from the base. An examination at once disclosed the object to be an empty pupal case and a closer examination enabled me to determine it as the pupal case of the "bee-hole" borer. It was in position as described above. The chrysalis case was quite fresh and the moth must have issued some time within the previous 48 hours. Another larger one, probably that of a female, was discovered in the plantation. The discovery points to the fact that the moths leave the trees in Tenasserim as early as the middle of March and probably on through a portion of April. Since the rains commence here in May, this was what might have been expected. I have already alluded to the fact that a patch of what may prove to be the eggs of this insect was discovered on bark of one of the trees in this plantation.

Note 2.—Portions of the stems of three teak trees containing living larvæ and a pupa *in situ* in the "bee-holes" were taken from the Mohnyin Forest to Rangoon and from there on my departure from Burma a month later to Calcutta. My object was to endeavour to breed out some moths and thus to identify the insect which I was of opinion would prove to be a species of *Duomitus*. This is always a difficult operation, since the wood as soon as cut commences to dry and the larva or pupa either dries up and dies or owing to the contraction the pupa is unable to make its way up the tunnel to allow the moth to escape. Mr. Nelson Anandale, Deputy Superintendent, Indian Museum, kindly undertook to look after my specimens for me until my touring came to an end. I have received a communication from him informing me that a moth issued during the first days of June and proved to be *Duomitus ceramicus*, Wlk.

the most wonderful instinct in this operation, as they appear to know that the end of the tunnel will be between 9 and 12 inches above the exit hole on the bark and bore in accordingly at this distance. It is probable that these birds exert a considerable check upon the increase of the insect, but their help in this respect can scarcely be called desirable, since they, in addition to often considerably enlarging the exit holes of the borers, drive other and larger holes into the wood, these holes being subsequently covered over and concealed by the growth of fresh outer layers of wood or, owing to "weathering," causing decay and rot to set up in the timber.

XI.—Results of the attack to the timber.

Three classes of damage are caused to the timber as a direct result of the attacks of this pest.

(*a*) *Faults in the Timber.*

Since the caterpillar attacks and feeds in the bast and sap wood of green trees and that these trees still continue their growth after the pest has matured and left by the exit hole, the deep irregular depressions in the sap wood become gradually covered over by succeeding layers of wood until they are completely buried within the timber. There is, however, often a fault between the superimposed layers of the wood and the layers below them at the place where the irregular depression occurs, the intervening layers of wood having been eaten away by the caterpillar and a proper junction of the new layers not having taken place.

(*b*) *The "bee-holes."*

It is scarcely necessary to describe these further. We have already seen that their presence may be apparent on the outside of the timber in the form of the exit holes of the insect, or the tunnel and exit hole may have become entirely enclosed within the wood. In the case of badly attacked trees, *i.e.*, trees which have supported numbers of larvæ in successive years almost all through their lives,

the timber is so riddled and contains so large a number of "bee-holes" and tunnels that it is almost entirely worthless for any purpose save that of firewood. The losses thus occasioned are serious and are of course aggravated by the fact that it is not always possible to tell whether a log is "bee-holed" or not. This latter would seem to be due to the fact that in some localities the insect confines itself to the younger trees, and thus by the time the tree has attained a felling size, the whole of the evidences of the former presence of this pest in the tree have become buried within the wood and will only become apparent when the log comes into the saw mill and is cut up.

(*c*) *Wood-peckers.*

Although these birds are present in the forest in the guise of friends, their attacks on the trees are to be feared almost as much as those of the insect. We have seen that they bore conical-shaped holes down into the wood to get at the grubs and, although in this way they diminish the number of the latter which will reach maturity, the result of their action on the timber is serious, this being more especially the case with the younger trees. In the case of these latter these large holes either become enclosed inside the wood and are thus hidden in what appears to be a fine sound log or they "weather" badly and, under the influence of water and fungi, set up rot in the wood. In either case their action is most detrimental to the timber.

XII.—Results of the attack in the Forest.

(*a*) *High natural Forest.*

Further observations are required before one can discuss with profit the real extent of the damage done by the insect in the Burman Teak Forests. From information already given me and from my own observations it appears to be much more plentiful in some localities than in others and in fact to appear to have had a preference for the trees of certain areas, whilst others are almost free from it. I say "to have had" since the evidence which has been

gathered upon the "bee-hole" borer in the past has been entirely taken from old trees in the forest (as evidenced by external exit holes) and sawn logs in the various mills. From this latter evidence it would appear that trees are rarely killed by the insects, since trees whose timber has subsequently been found to be almost entirely riddled through right down to the heart (by successive insects over a long series of years) have been able to reach a great size and therefore age.

I am at present engaged in obtaining statistics on the subject of the distribution of the pest as represented by the different degrees in which the forests are infested, together with particulars as to the aspect, soil, rainfall, etc., of these localities.

In the Mohnyin Reserve I have seen trees of 9 inches diameter with as many as nine "bee-holes" in the lower 8 foot of the bole; several of these had been subsequently enlarged by wood-peckers. In addition, there were also one or more large wood-pecker holes, made by the birds in extracting the grubs. It may be taken as certain that forests containing such evidences of the presence of the pest will be found to have the timber of their old mature trees badly riddled.

From observations made on logs in the Kado Timber Depôt at Moulmein and information supplied it appears that areas in the Thaungyin Reserves of the Division of that name and the Sinswe Reserve of the West Salween Division are badly infested with the borer. The Ataran Forests, on the other hand, appear to be comparatively free from the insect.

(*b*) *Plantations.*

From the short investigations I have already been able to make upon the results of the attack of the caterpillar in plantations in the Mohnyin Reserve in Katha and in the Shwegyin plantations on the Salween river, it is possible to state that this pest is, in localities where it is abundant, probably one of the most serious the Forester has to deal with at present in Burma. It will apparently attack saplings from two years of age and upwards, and the state to which

a plantation can be reduced by its attacks is almost incredible. The following is a description made of the present position of a portion of an 1896 plantation in the Mohnyin Reserve. In this particular forest the insect appeared to be very abundant, and probably from 40 to 50 per cent. (and I think the estimate is below the mark) of the trees in the area inspected showed the present attacks or results of past attacks of the caterpillar. Some of the young trees have several holes in them and in many cases wood-peckers have increased the size of these or bored fresh ones to get at the grubs: *e.g.*, one tree had been attacked by three borers and in each instance a wood-pecker had bored in above the "bee-hole" with the result that the stem already contains six holes, the tree being still under ten years of age. This portion of the plantation must, I think, already be looked upon as ruined by the insect, and yet I have been unable to find any reports of its attacks in the reserve journals. If the trees are allowed to remain on the ground, the holes will gradually become closed over and thus concealed within the wood. The timber of such trees will, however, be worthless. Several caterpillars were cut out of trees in this plantation. In another two-year old plantation in this forest a caterpillar was taken from the base of the stem of a young sapling, up the centre of which it had bored its pupating tunnel.

In the Shwegyin plantation on the Salween river the borer was found to be present. Fifteen comparatively fresh "bee-holes" were counted in the trees on this area and from evidences on the stems it appeared probable that the trees contained other closed over, or almost closed over, ones. Two empty fresh pupal cases were taken from trees.

In plantations visited at Thaubya (1902) and Natchoung (1889, 1891, 1900 and 1902) on the Ataran river no trace of the borer was visible, although a careful search was instituted.

With such evidences of the powers of this pest for injury before one it may be suggested that careful statistics are required as to the localities where the insect is at present abundant, and that plantations in such localities should not be created unless the necessary constant

supervision required to keep the insect from obtaining a footing in them is possible.

XIII.—Proposed steps to be taken to clear the plantations.

In the present state of the investigations into the habits and action of this pest (although when the observations in this note have been confirmed and the moth obtained* we shall know all that is required to endeavour to combat it practically) it is too early to say what measures can be taken to endeavour to reduce its numbers in the forests. We are in a position, however, to suggest certain steps which should be taken to clear it out of the plantations and to endeavour to keep it out in the future. It may be stated at once that constant supervision will be necessary since we have seen that the pest does not apparently confine itself to any particular age or size of tree, the only desideratum being that the tree should contain a certain amount of hard wood into which the caterpillar can tunnel in order to pupate. This constant supervision will not be so difficult to maintain, provided the establishment permits of it (and this must be pre-supposed since it is useless forming the plantations only to have them ruined at the very outset by the borer), since I found that the Burma coolies employed at Mohnyin had a considerable knowledge of natural history and once they were shown what was required became quite adept at searching and finding trees containing "bee-holes" with living larvæ in them. It has been shown that the caterpillar feeds under the bark until full-grown and that on attaining full size it has to bore a hole through the bark to the outside so as to be able to eject through it the sawdust resulting from its tunnelling operations in the wood. A careful inspection of the trees at this period would enable the position of boring larvæ to be ascertained and they could be removed *before* they had bored down into the wood.

(ii) Again, it is probable that whilst the caterpillars are feeding under the bark their presence will be visible from the outside by

* *Vide* footnote No. 2 on page 12.

sap oozing down on the bark from the spot at which they are working. If this proves to be the case, it will be possible to kill them off at a still younger stage.

The above will mean that a close supervision over the plantations must be maintained through the rainy months, and whether this supervision has or has not been maintained can always be checked by visiting the plantations in the cold weather and seeing whether there are fresh "bee-holes" on the trees. Should this be found to be the case, the supervision there has been slack.

(iii) In the matter of badly infested plantations all badly attacked trees should be cut out; this operation being carried out, however, in the cold weather when they will be certain to contain all the caterpillars from the eggs laid in the previous season.

(iv) In localities where from the evidence in the forest the insect is known to be plentiful I would deprecate the formation of pure plantations of teak, it being probable that mixed ones would be much less liable to attack.

(v) Some attention should be paid to the wood-peckers with the object of preventing them attacking infested trees in plantations. In the Mohnyin Reserve these birds were very plentiful, and the damage they are doing to the young trees is too serious to be disregarded. When they attack the tree with the object of getting out the grub, the latter has committed all the damage he is going to do and therefore the wood-pecker, as far as the particular tree is concerned, only makes matters worse. In the interest of the timber it cannot be held that the bird counterbalances the evil it does by the number of insects it destroys, thus preventing them coming to maturity and reproducing themselves.

XIV.—Further observations required in the Forest.

Some of these have already been alluded to under XII. Amongst the most important is a confirmation, by officers stationed in different parts of Burma where "bee-hole" timber is plentiful, of the life history of this pest, as sketched above.

An answer is also required, if possible, as to the reason for the stated fact that the insect is more abundant in some localities than others. How do these localities differ from neighbouring unaffected ones? A very careful inspection of all plantations in the country is necessary with a view to ascertaining whether they are attacked by the pest and, if infested, whether badly; for if the latter, they are only serving as so many centres from which the insect will radiate outwards and spread into unaffected areas.

XV.—Points in the life history requiring further observation.

A confirmation of the life history as ascertained in the Mohnyin Forest in Katha, and to a lesser extent in Tenasserim, is required from officers in other parts of Burma, and in addition we require to know—

(1) When the moth leaves the tree in Burma (excluding Tenasserim) and how long it lives.

(2) Where it lays its eggs. Does it lay more than one? If so, are they laid singly or together? If singly, are they laid on the same tree or on different ones?

(3) When do the eggs hatch out?

(4) How many months does the caterpillar spend—

(*a*) feeding in the bast and sap wood;

(*b*) in boring the "bee-hole" (tunnel and pupating chamber) in the wood;

(*c*) in the pupating chamber before changing to the chrysalis stage.

(5) How long is spent in the chrysalis stage?

(6) The different localities in Burma in which the insect is to be found.

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the wood in the early days of Forest operations in Tenasserim. In his Report on the Teak Forests of Tenasserim Dr. H. Falconer, F.R.S., Superintendent of the Botanical Gardens, Calcutta, made the following allusions to this subject as long ago as 1851 :—"The mixture of this light dead timber, with unseasoned logs which have been felled green and logs flawed with holes and clefts from the Thaungyin, in the shipments made to England is generally considered to have been the cause of the bad repute into which the Tenasserim teak has fallen at home for shipbuilding.....The two latter circumstances had more to do with the result than the first." "The tree during its growth does not seem to suffer much from the ravages of parasitical insects. Captain Tremenheere mentions that the stem is attacked by a beetle in the Thangyin which bores teredo-like holes. I observed no marks of such an insect in the Ataran Forests."

Captain Guthrie, Superintendent of Forests in the Tenasserim provinces, wrote in a report dated 20th June 1845, "Of the Thaungyin teak I may remark that I have seen it growing and thriving in every variety of locality; it has generally the advantage of carrying its girth well to a great height, not tapering quickly; it appears to be somewhat liable to small cells, isolated, but which appear in sawing up."

The presence of these "bee-holes" in the wood has resulted in two serious drawbacks :—

(1) Reduction in the amount of timber available for export owing to the trees from certain localities having been found to be badly "bee-holed." This results in smaller amounts being available in the home markets.

(2) Serious losses to the merchant engaged in extracting the wood.

Under the latter head I have been supplied with the following figures (at Moulmein) :—

			R	a.	p.
Value of good sound teak log, 24′ × 5′ middle girth free		from bee-holes . . .	160	0	0
Do.	do.	with a few bee holes . .	92	8	0
Do.	do.	with numerous bee-holes . .	40	0	0
Do.	do.	entirely riddled . . .	7	0	0
(The log would be cut up and sold as firewood.)					

Soon after my arrival in Burma I paid a visit to the Saw Mills of Messrs. Steel & Co. in Rangoon, where the manager very kindly showed me a number of attacked squares and, in fact, teak material of all sorts. An exceptionally badly riddled square was cut up in order that the tunnels might be traced from the orifice opening out on the outer surface to their extremities in the wood.

Two points were ascertained:—

(i) That the tunnel curved up the stem soon after entering and ended in a slightly wider chamber at its upper extremity. Its section was oval-elliptical.

(ii) That the tunnel did not necessarily open on to the outside of the squares. In taking off slabs with a circular saw it became apparent that tunnels both commenced and ended within the wood itself.

From an examination of the tunnel it was at once apparent that, although the work of an insect, it was not the work of one of the carpenter bees (*Xylocopa*). These bees usually work in colonies, the tunnels being placed closely adjacent and being invariably large in section and circular. Nor was it the work of a wood wasp (Sirex); the grub of the latter tunnels in a very irregular manner in the wood, the gallery running at various angles, and, in addition, there is always an exit gallery bored straight from the pupal chamber to the outside. This reduced the matter to three probable groups. Two of beetles, *Buprestidæ* and *Cerambycidæ* and one of the *Heterocera* or moths (the wood-boring families *Cossidæ*, *Arbelidæ*, etc.).

From my examination of the tunnels I was inclined to think they were either Buprestid or Heterocerous. The difficulty, however, was that the tunnels, though varying in size, were each individually of the same width throughout. In other words, the whole tunnel appeared to have been made by the *full grown* insect; whether in its larval or mature stage had yet to be ascertained. I could find no trace of the gradually increasing gallery made by a larva as it grows from its young to its full-grown condition; nor did there appear to be any separate exit gallery. These facts rather led to the

assumption that the insect was one of those which spend the whole of their grub stage (until full size is attained) feeding beneath the bark in the bast and sap wood, only boring into the wood to pupate, and this was a point to be evidently kept in view in studying the attack in the forest. The fact that the tunnels varied greatly in width was not of great importance since the individuals of many insects of one and the same species vary greatly in size, as also do the males and females of the same species.

The second of the above points was of great importance since it seemed to indicate that the tree had been attacked whilst alive and in a younger stage, the exit hole on the outside of the stem having been subsequently covered over by later layers of wood.

II.—Points to be studied.

My examination of the timber in Messrs. Steel & Co.'s Saw Mill enabled me to draw up the following questions which required answering from direct observations in the forest:—

(1) The exact position on the tree and direction of—

- (*a*) the entrance hole;
- (*b*) the main gallery;
- (*c*) the pupal chamber;
- (*d*) the exit hole;

(2) Where the eggs are laid.

(3) Length of time spent in the larval or grub stage and where and how the larva feeds.

(4) Length of time passed in the pupal or chrysalis stage and where this stage is passed.

(5) At what time of the year the insect quits the tree and how.

(6) The nature of the insect, whether wood wasp, carpenter bee, beetle (buprestid or longicorn) or a boring heterocerous (moth) caterpillar.

(7) Are green standing trees in the forest attacked?

(8) Are the trees only attacked after being girdled?

(9) Are dead trees attacked by the insect?
(10) At what age are the trees attacked?

III.—Tharrawaddy Teak plantation Thinnings.

"Bee-holes" in teak in the Tharrawaddy Division are said to be by no means common. We found, however, what Mr. Troup, the Divisional Officer, considered to be an example of such in an 1888 plantation in the Kadin Bilin Forest. In the light of subsequent investigations I am now able to corroborate Mr. Troup. This plantation had been thinned last year and the thinned trees were lying in the coupe, since the thinnings here are not sold. Whilst cutting up and examining one of these trees for *Scolytidæ*, with one or two species of which the wood was being riddled, we came upon a cavity or tunnel in the stem and traced it up to what appeared to have been a pupating chamber of an insect, situated in the long axis of the tree in the centre of the heart wood. The top of the tunnel or former exit hole of the pest had three rings of sap wood superimposed above it. It was therefore justifiable to suppose that the attack had been made upon the tree whilst still living, the entrance or exit hole having been closed up by the subsequent growth of the tree.

IV.—Examination of Timber from the Mohnyin Reserve in the Kadu Depôt, Katha Division.

On my arrival at Kadu in the Katha Division, Upper Burma, I examined a number of teak logs in the Depôt and also some standing dead girdled trees. The logs had all come from the Mohnyin Reserve, the teak trees of which were earning an unenviable notoriety owing to the number of "bee-holes" the timber contained. I found that a majority of the logs showed "bee-holes" on the outside as also sections of them on the cut ends. The holes were usually oval-elliptical in shape and appeared to vary greatly in size. Many were badly "weathered," the opening on the outside being

much enlarged, the enlargement being due to either moisture or to the attacks of wood-peckers searching for the grubs. The holes were either widely scattered, only two or three appearing on the outside of a tree, or there were several closely adjacent to one another. A careful examination of the holes and the tunnels into which they led disclosed the fact that these latter invariably curved upwards soon after leaving the outside. As already seen in the Saw Mill at Rangoon, the diameter of the tunnel was the same all the way up with the exception that the last 2—2½ inches were slightly enlarged. I had noticed in the wood examined in Rangoon that this enlarged area was often lined with a layer of calcareous matter, but this was not the case with the galleries examined here.

V.—Examination of Standing trees in the Mobnyin Reserve.

(*a*) *Dead Trees.*

Dead standing trees in the forest exhibit much the same appearance as the felled logs. The "bee-holes" are to be seen on the outside often "weathered" and enlarged and are also to be found inside the timber when cut up, the end of the hole having been closed over by subsequent growth of wood. In no instance, however, have I found fresh attacks, *i.e.*, fresh "bee-hole" borings, in dead trees; the holes in every case in this latter having all the appearance of having been made some time previously.

(*b*) *Girdled and dying trees.*

It was perhaps but natural that in the first instance one should entertain the opinion that there might be some connection between the custom of girdling the green standing teak trees and leaving them several years in the forest before extraction and the "bee-hole" attacks. Whilst, however, my examinations showed me that standing girdled dying trees contained the "bee-holes" both outside and also inside the wood, I found no evidence to prove that the holes in the wood were made by insects attacking the trees after they had

been girdled and whilst the bast and sap wood were slowly dying. In the case of the Sâl tree in India, and in fact of probably the majority of trees, girdling standing trees in the forest would almost certainly be followed by various species of wood-boring insects at once depositing their eggs in or beneath the bark and the resultant grubs would feed at first in the dying bast and sap wood and then, as they grew older, tunnel directly into the heart wood. The teak, so far as my observations go, appears to be an exception to this rule.

(*c*) *Green Trees.*

It was when I turned my attention to the examination of green standing trees in the Mohnyin Reserve that I commenced to understand the real position of affairs and to make the first of a series of observations which have led to the discovery of the true author of the "bee-holes" in teak, of their mode of origin and of a considerable portion of the life history of the "bee-hole" borer.

I have already shown that the "bee-holes" are to be found with their entire length and entrance (or exit) hole buried deep in the heart wood of the tree. We have also seen that quite small trees (16-year old), as instanced in the Tharrawaddy Plantations, may have a "bee-hole" in the wood entirely covered up by several later layers of sap wood. This led to the possible assumption that green trees were attacked by the author of the "bee-hole" and observations in the forest quickly showed that such was actually the case. Green trees showed the "bee-holes" on the outer surface of the bark in almost every stage of formation and age; the hole newly gnawed to the outside of the bark, from which sap was seen to be oozing and below which, either on projecting inequalities of the bark beneath the hole, or at the foot of the tree, saw dust and gnawed wood from the tunnel were to be found; older holes with the outer bark closing over them, the size of the external hole still present depending upon the age of the tunnel beneath; and finally trees in which the holes were entirely closed over, but which still betrayed, by the presence of a dark coloured or black point on the outside bark, the existence of a "bee-hole" beneath.

Once these outside evidences of the "bee-hole" have been fully recognised, the former presence or, as we shall see later, actual presence of this pest can be detected unerringly.

A discovery of a most serious nature was made whilst examining the trees in plantations in this reserve. It was proved beyond a possibility of doubt that the insect attacks trees of all sizes down to the youngest 2-year old sapling which contains at its base woody tissue.

VI.—The nature of the Insect which causes the "Bee-hole."

The discovery of fresh "bee-holes" in green trees led to the narrowing down of the possible authors of the damage and on splitting up some logs selected from a badly attacked green tree standing in the forest I obtained the "bee-hole" borer. It proved to be a large brightly marked caterpillar of the sub-order *Heterocera* or moths, thus discrediting its popular name of "bee-hole" and disposing of the much more probable theories that the holes were the work of one of the boring beetles belonging to the families *Buprestidæ* or *Cerambycidæ*.

VII.—The method of attack as determined from inspections of green, girdled and dead trees.

The egg is, I think, undoubtedly laid by the moth upon the bark,* or under a flake or ridge. If more than one egg is laid at any one spot only one develops, or, if more than one, the young caterpillars separate and bore into the bark at different spots. This is borne out by the fact that only one insect is found occupying the "bee-hole." The young larva on hatching out bores through the

* Since writing this, whilst inspecting the Shwegyin Plantation on the Salween river in Tenasserim, a patch of eggs which *may* prove to be those of this insect was discovered on the stem of a green teak. These eggs were flat, roundish and yellow, some 150 in number and laid close together in a blackish gummy substance which glued them on. Two moths had already issued from trees in this plantation. These eggs were taken on March 11th.

bark and feeds probably at first only in the bast, but later on, when its mandibles (biting-jaws) have become stronger, it eats into the sap wood as well. It bores an irregular shaped gallery having several irregularly-radiating arms, the total length being usually about four inches, with a breadth of three inches. As the grub becomes older it eats down into the sap wood, the depressions in the latter being deeper in the central part of the irregular shaped cavity. When full grown it bores into the heart wood and excavates a tunnel which curves upwards, is about nine to thirteen inches in total length, and is slightly enlarged at its upper end, the enlarged portion being from 1½ to 2 inches in length. This tunnel appears to usually start from the centre of the irregular depression, is of but slightly larger section than the body of the caterpillar and has the same width throughout, except at the upper end. The enlarged portion at the top is the pupating chamber and in it the caterpillar changes to the pupal or chrysalis stage, turning round so as to face *down* the hole before doing so. The tunnel is kept quite free of wood sawdust and excreta, these being ejected from it through a hole gnawed in the bark just over the entrance of the tunnel into the wood; the hole really forming a prolongation of the latter, but separated by the deep irregular depression in the sap wood. Before finally pupating the caterpillar again crawls up the tunnel and spins a close firm taut silken mesh across the tunnel just below the spot at which it opens out into the depression in the sap wood. It then proceeds backwards up the tunnel and spins a second of these meshes just below the point where the gallery opens out into the wider pupal chamber. The damage this insect does to the tree is then complete and the "bee-hole" in the wood has been made. An examination of all trees containing "bee-holes" on the outside will show the irregular depression in the sap wood. If the tree is dead, this depression may be considerably "weathered," but it is always distinguishable. If the tree is green and the external hole is nearly closed up, on shaving off the bark at the spot the layers of bast gradually closing over the depression and hole will be disclosed and beneath these the irregular depression with the entrance to the tunnel at or near the centre.

VIII.—Description of larva (caterpillar), pupa, chrysalis and moth.

Larva.—A large robust caterpillar consisting of a head and twelve segments; the latter swollen and distinct, skin shining with a satiny lustre. It tapers both anteriorly and posteriorly, the 12th or last segment being much smaller than the rest. Head small, shining, dark walnut-brown above and on sides; mouth parts black. First thoracic segment (the segment following the head) shining, light walnut-brown dorsally, with a truncate ovalshaped patch behind set with asperities and protuberances (probably to enable the grub to push out wood-dust particles from the tunnel); 2nd segment white with three tubercles placed transversely on each side of the dorsal median line; rest of segments to 11th inclusive satiny-white, with a broad transverse bright pink band on each, commencing just below the front edge of the segment and extending to about its middle; a large brown spot (spiracle) with a pink centre on each of the segments 2-11 (inclusive), just above the median lateral (side) line; 12th segment small, pink in front and a dirty-brownish black behind. A round black spot above and below each spiracle. Four small brown spots dorsally on each segment; two in the centre of the pink band one on either side of median line and the other two anteriorly on the white band set slightly laterally to the ones above them. These spots seem to partake of the nature of minute tubercles and may help the larva in its movements in the tunnel. Length $1\frac{3}{4}$ to 2 inches. All the segments with the exception of the 12th shining, with a satiny lustre. Under-surface satiny-white, as also are the three pairs of front legs (on the first three segments behind head) and the abdominal ones, the latter with well-marked clasping pads. Under-surface is flat, upper convex.

Pupa.—Stout, elongate, tapers slightly posteriorly. Chestnut-brown, darker at thoracic end; antennæ and wings of future moth distinctly visible as raised lumps on the pupal skin at the upper end. Colour lighter posteriorly; the abdominal segments canary yellow beneath and at sides, with narrow bands of this colour marking the intervals of the segments. The spiracles prominent as brown spots

on sides of abdominal segments. Under-surface lighter in colour, length 1½ to 2½ inches.

Moth.—A large moth with long and narrow wings. The head thorax and body pale ochreous brown, more or less suffused with black; patches of black scales at each side of hinder portion of thorax. Fore wing pale ochreous brown with blackish streaks and an irregular whitish patch in the outer angle which tails off in a series of decreasing spots. Hind wing fuscous, slightly marbled with black. Expanse of wings $4\frac{1}{6}$th inch.

The moth does not appear to have been taken in Burma since Hampson in the Fauna only gives the habitat as Sikkim; Nias; Ceram.

IX.—Probable Life History.

The egg is almost certainly laid upon the bark of the tree probably in the hot season before the monsoon bursts (*vide* footnote on p. 8). The caterpillar probably hatches out within a short period and feeds as I have shown in the bast and subsequently on the sap wood, finally pupating in the interior of the wood. It is probable that it only spends the monsoon months (with perhaps a portion of the preceding hot weather) in feeding and attaining its full size, and towards the commencement of the cold weather it tunnels into the tree. These conjectures are borne out by the fact that no half grown or smaller larvæ have been found in the irregular depressions beneath the bark and therefore it would appear that the insect passes through the whole of its life cycle from egg to moth in a year. Since a number of larvæ were found at the end of February at the top of the tunnels in the wood, but only one pupa, it appears that the cold weather is passed through in the larval stage in Upper Burma, perhaps partly in boring the pupating tunnel and chamber, and that the larva only changes to the pupal or chrysalid condition on the approach of the hot weather. I do not know as yet how long is spent in the pupal stage nor when the moth issues in Upper Burma, but the former is probably short, the latter issuing sometime during the hot weather. To enable the moth to issue, the pupa would work its way up the tunnel by means of the minute circles of spines situated

on each of the abdominal segments, rupturing the mesh nets spun across the tunnel near its upper end and near the mouth in its progress, and projecting, for about half its length from the hole bored by the larva in the bark.* The moth probably issues at night and flies and pairs at night. The life history will vary slightly in Upper and Lower Burma and again in Tenasserim.

X.—Enemies.

As far as my present observations have been carried, the chief enemies of the "bee-hole" borer would seem to be wood-peckers. I noted two species in Katha: the one blackish-green, the other greyish-green.

They are both called *Thit tauk lauk* by the Burmans. These birds "tap" the "bee-hole" tunnels by boring down through the wood, above the exit hole on the bark, until they reach the tunnel and the grub which is to be found at the end of it. They exhibit

* *Note 1.*—Since the above was written some teak areas and plantations on the Salween River have been visited in company with the Conservator. We inspected the Shwegyin plantation and searched for the borer. Mr. Manson pointed out something protruding from the bark of one of the trees about eighteen inches up from the base. An examination at once disclosed the object to be an empty pupal case and a closer examination enabled me to determine it as the pupal case of the "bee-hole" borer. It was in position as described above. The chrysalis case was quite fresh and the moth must have issued some time within the previous 48 hours. Another larger one, probably that of a female, was discovered in the plantation. The discovery points to the fact that the moths leave the trees in Tenasserim as early as the middle of March and probably on through a portion of April. Since the rains commence here in May, this was what might have been expected. I have already alluded to the fact that a patch of what may prove to be the eggs of this insect was discovered on bark of one of the trees in this plantation.

Note 2.—Portions of the stems of three teak trees containing living larvæ and a pupa *in situ* in the "bee-holes" were taken from the Mohnyin Forest to Rangoon and from there on my departure from Burma a month later to Calcutta. My object was to endeavour to breed out some moths and thus to identify the insect which I was of opinion would prove to be a species of *Duomitus*. This is always a difficult operation, since the wood as soon as cut commences to dry and the larva or pupa either dries up and dies or owing to the contraction the pupa is unable to make its way up the tunnel to allow the moth to escape. Mr. Nelson Anandale, Deputy Superintendent, Indian Museum, kindly undertook to look after my specimens for me until my touring came to an end. I have received a communication from him informing me that a moth issued during the first days of June and proved to be *Duomitus ceramicus*, Wlk.

the most wonderful instinct in this operation, as they appear to know that the end of the tunnel will be between 9 and 12 inches above the exit hole on the bark and bore in accordingly at this distance. It is probable that these birds exert a considerable check upon the increase of the insect, but their help in this respect can scarcely be called desirable, since they, in addition to often considerably enlarging the exit holes of the borers, drive other and larger holes into the wood, these holes being subsequently covered over and concealed by the growth of fresh outer layers of wood or, owing to "weathering," causing decay and rot to set up in the timber.

XI.—Results of the attack to the timber.

Three classes of damage are caused to the timber as a direct result of the attacks of this pest.

(*a*) *Faults in the Timber.*

Since the caterpillar attacks and feeds in the bast and sap wood of green trees and that these trees still continue their growth after the pest has matured and left by the exit hole, the deep irregular depressions in the sap wood become gradually covered over by succeeding layers of wood until they are completely buried within the timber. There is, however, often a fault between the superimposed layers of the wood and the layers below them at the place where the irregular depression occurs, the intervening layers of wood having been eaten away by the caterpillar and a proper junction of the new layers not having taken place.

(*b*) *The "bee-holes."*

It is scarcely necessary to describe these further. We have already seen that their presence may be apparent on the outside of the timber in the form of the exit holes of the insect, or the tunnel and exit hole may have become entirely enclosed within the wood. In the case of badly attacked trees, *i.e.*, trees which have supported numbers of larvæ in successive years almost all through their lives,

the timber is so riddled and contains so large a number of "bee-holes" and tunnels that it is almost entirely worthless for any purpose save that of firewood. The losses thus occasioned are serious and are of course aggravated by the fact that it is not always possible to tell whether a log is "bee-holed" or not. This latter would seem to be due to the fact that in some localities the insect confines itself to the younger trees, and thus by the time the tree has attained a felling size, the whole of the evidences of the former presence of this pest in the tree have become buried within the wood and will only become apparent when the log comes into the saw mill and is cut up.

(*c*) *Wood-peckers.*

Although these birds are present in the forest in the guise of friends, their attacks on the trees are to be feared almost as much as those of the insect. We have seen that they bore conical-shaped holes down into the wood to get at the grubs and, although in this way they diminish the number of the latter which will reach maturity, the result of their action on the timber is serious, this being more especially the case with the younger trees. In the case of these latter these large holes either become enclosed inside the wood and are thus hidden in what appears to be a fine sound log or they "weather" badly and, under the influence of water and fungi, set up rot in the wood. In either case their action is most detrimental to the timber.

XII.—Results of the attack in the Forest.

(*a*) *High natural Forest.*

Further observations are required before one can discuss with profit the real extent of the damage done by the insect in the Burman Teak Forests. From information already given me and from my own observations it appears to be much more plentiful in some localities than in others and in fact to appear to have had a preference for the trees of certain areas, whilst others are almost free from it. I say "to have had" since the evidence which has been

gathered upon the "bee-hole" borer in the past has been entirely taken from old trees in the forest (as evidenced by external exit holes) and sawn logs in the various mills. From this latter evidence it would appear that trees are rarely killed by the insects, since trees whose timber has subsequently been found to be almost entirely riddled through right down to the heart (by successive insects over a long series of years) have been able to reach a great size and therefore age.

I am at present engaged in obtaining statistics on the subject of the distribution of the pest as represented by the different degrees in which the forests are infested, together with particulars as to the aspect, soil, rainfall, etc., of these localities.

In the Mohnyin Reserve I have seen trees of 9 inches diameter with as many as nine "bee-holes" in the lower 8 foot of the bole; several of these had been subsequently enlarged by wood-peckers. In addition, there were also one or more large wood-pecker holes, made by the birds in extracting the grubs. It may be taken as certain that forests containing such evidences of the presence of the pest will be found to have the timber of their old mature trees badly riddled.

From observations made on logs in the Kado Timber Depôt at Moulmein and information supplied it appears that areas in the Thaungyin Reserves of the Division of that name and the Sinswe Reserve of the West Salween Division are badly infested with the borer. The Ataran Forests, on the other hand, appear to be comparatively free from the insect.

(*b*) *Plantations.*

From the short investigations I have already been able to make upon the results of the attack of the caterpillar in plantations in the Mohnyin Reserve in Katha and in the Shwegyin plantations on the Salween river, it is possible to state that this pest is, in localities where it is abundant, probably one of the most serious the Forester has to deal with at present in Burma. It will apparently attack saplings from two years of age and upwards, and the state to which

a plantation can be reduced by its attacks is almost incredible. The following is a description made of the present position of a portion of an 1896 plantation in the Mohnyin Reserve. In this particular forest the insect appeared to be very abundant, and probably from 40 to 50 per cent. (and I think the estimate is below the mark) of the trees in the area inspected showed the present attacks or results of past attacks of the caterpillar. Some of the young trees have several holes in them and in many cases wood-peckers have increased the size of these or bored fresh ones to get at the grubs: *e.g.*, one tree had been attacked by three borers and in each instance a wood-pecker had bored in above the "bee-hole" with the result that the stem already contains six holes, the tree being still under ten years of age. This portion of the plantation must, I think, already be looked upon as ruined by the insect, and yet I have been unable to find any reports of its attacks in the reserve journals. If the trees are allowed to remain on the ground, the holes will gradually become closed over and thus concealed within the wood. The timber of such trees will, however, be worthless. Several caterpillars were cut out of trees in this plantation. In another two-year old plantation in this forest a caterpillar was taken from the base of the stem of a young sapling, up the centre of which it had bored its pupating tunnel.

In the Shwegyin plantation on the Salween river the borer was found to be present. Fifteen comparatively fresh "bee-holes" were counted in the trees on this area and from evidences on the stems it appeared probable that the trees contained other closed over, or almost closed over, ones. Two empty fresh pupal cases were taken from trees.

In plantations visited at Thaubya (1902) and Natchoung (1889, 1891, 1900 and 1902) on the Ataran river no trace of the borer was visible, although a careful search was instituted.

With such evidences of the powers of this pest for injury before one it may be suggested that careful statistics are required as to the localities where the insect is at present abundant, and that plantations in such localities should not be created unless the necessary constant

supervision required to keep the insect from obtaining a footing in them is possible.

XIII.—Proposed steps to be taken to clear the plantations.

In the present state of the investigations into the habits and action of this pest (although when the observations in this note have been confirmed and the moth obtained* we shall know all that is required to endeavour to combat it practically) it is too early to say what measures can be taken to endeavour to reduce its numbers in the forests. We are in a position, however, to suggest certain steps which should be taken to clear it out of the plantations and to endeavour to keep it out in the future. It may be stated at once that constant supervision will be necessary since we have seen that the pest does not apparently confine itself to any particular age or size of tree, the only desideratum being that the tree should contain a certain amount of hard wood into which the caterpillar can tunnel in order to pupate. This constant supervision will not be so difficult to maintain, provided the establishment permits of it (and this must be pre-supposed since it is useless forming the plantations only to have them ruined at the very outset by the borer), since I found that the Burma coolies employed at Mohnyin had a considerable knowledge of natural history and once they were shown what was required became quite adept at searching and finding trees containing "bee-holes" with living larvæ in them. It has been shown that *the caterpillar feeds under the bark until full-grown and that on* attaining full size it has to bore a hole through the bark to the outside so as to be able to eject through it the sawdust resulting from its tunnelling operations in the wood. A careful inspection of the trees at this period would enable the position of boring larvæ to be ascertained and they could be removed *before* they had bored down into the wood.

(ii) Again, it is probable that whilst the caterpillars are feeding under the bark their presence will be visible from the outside by

* *Vide* footnote No. 2 on page 12.

sap oozing down on the bark from the spot at which they are working. If this proves to be the case, it will be possible to kill them off at a still younger stage.

The above will mean that a close supervision over the plantations must be maintained through the rainy months, and whether this supervision has or has not been maintained can always be checked by visiting the plantations in the cold weather and seeing whether there are fresh "bee-holes" on the trees. Should this be found to be the case, the supervision there has been slack.

(iii) In the matter of badly infested plantations all badly attacked trees should be cut out; this operation being carried out, however, in the cold weather when they will be certain to contain all the caterpillars from the eggs laid in the previous season.

(iv) In localities where from the evidence in the forest the insect is known to be plentiful I would deprecate the formation of pure plantations of teak, it being probable that mixed ones would be much less liable to attack.

(v) Some attention should be paid to the wood-peckers with the object of preventing them attacking infested trees in plantations. In the Mohnyin Reserve these birds were very plentiful, and the damage they are doing to the young trees is too serious to be disregarded. When they attack the tree with the object of getting out the grub, the latter has committed all the damage he is going to do and therefore the wood-pecker, as far as the particular tree is concerned, only makes matters worse. In the interest of the timber it cannot be held that the bird counterbalances the evil it does by the number of insects it destroys, thus preventing them coming to maturity and reproducing themselves.

XIV.—Further observations required in the Forest.

Some of these have already been alluded to under XII. Amongst the most important is a confirmation, by officers stationed in different parts of Burma where "bee-hole" timber is plentiful, of the life history of this pest, as sketched above.

An answer is also required, if possible, as to the reason for the stated fact that the insect is more abundant in some localities than others. How do these localities differ from neighbouring unaffected ones? A very careful inspection of all plantations in the country is necessary with a view to ascertaining whether they are attacked by the pest and, if infested, whether badly; for if the latter, they are only serving as so many centres from which the insect will radiate outwards and spread into unaffected areas.

XV.—Points in the life history requiring further observation.

A confirmation of the life history as ascertained in the Mohnyin Forest in Katha, and to a lesser extent in Tenasserim, is required from officers in other parts of Burma, and in addition we require to know—

(1) When the moth leaves the tree in Burma (excluding Tenasserim) and how long it lives.

(2) Where it lays its eggs. Does it lay more than one? If so, are they laid singly or together? If singly, are they laid on the same tree or on different ones?

(3) When do the eggs hatch out?

(4) How many months does the caterpillar spend—

(*a*) feeding in the bast and sap wood;

(*b*) in boring the "bee-hole" (tunnel and pupating chamber) in the wood;

(*c*) in the pupating chamber before changing to the chrysalis stage.

(5) How long is spent in the chrysalis stage?

(6) The different localities in Burma in which the insect is to be found.

G. I. C. P. O.—No. 935 R. & A.—19-7-1905.—1,700.—P. M. M.